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Environmental Research Laboratories

Publication Abstracts

FY 1983

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FOREWORD

As the research arm of the National Oceanic and Atmospheric Administration (NOAA), the Environmental Research Laboratories (ERL) support the present responsibilities and develop the future services of NOAA. The laboratories conduct fundamental investigations needed to improve understanding of the geophysical environment. Programs include investigation of ocean processes and their interactions with the atmosphere; studies of the ocean environment as it is affected by waste disposal and development of energy and food resources; fundamental studies of the upper atmosphere and space environments; lower atmosphere research on the weather and climate; research on severe local storms, hurricanes, and tsunamis; studies of cloud processes; research on the environmental effects of regional and global pollution; and development of equipment, instruments, systems, and facilities for these programs.

A principal measure of the success of a research laboratory is its output of papers and reports. The listings (including abstracts when available) in the following pages are an index of ERL output for the period October 1, 1982, through September 30, 1983. This document includes all known articles published in journals for FY 1983 and those reports published within the official series of the laboratories, as well as conference proceedings and other reports.

Vernon E. Derr, Director
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CONTENTS

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*See AUTHOR INDEX, p. 145.

Abstracts for this volume were submitted print ready by each Laboratory. If no abstract accompanied the original publication, the words "No abstract" follow the bibliographic entry.

Sections are arranged alphabetically by Laboratory.

Entries within the Laboratory sections are arranged alphabetically by author. ERL authors' names are typed in all capital letters.

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AERONOMY LABORATORY

AL-001
ALBRITTON, D. L., I. Dotan, G. E. Streit, D. W. FAHEY, F. C. FEHSENFELD, and E. E. FERGUSON. Energy dependence of the O^- transfer reactions of O_3 and CO_3 with NO and SO_2. _Journal of Chemical Physics_ 78: 6614-6619 (1983).

The O^- transfer reactions of O_3^- and CO_3^- with NO and SO_2 were measured as a function of temperature in the range 170-605 K in a variable-temperature flowing afterglow system and as a function of center-of-mass kinetic energy in the range 0.04-2 eV in a flow-drift tube system. The rate constant in each case showed a marked energy dependence. The rate constants measured as a function of temperature were essentially the same as those measured as a function of kinetic energy in He and Ar buffer gases when the comparison is made at the same mean center-of-mass kinetic energy. The results imply that the reactions have negligible vibrational or rotational energy dependence.

AL-002
BALSLEY, B. B., D. A. CARTER, and W. L. ECKLUND. On the potential of radar observations for studying coupling processes between the ionosphere and middle atmosphere. In _Solar-Terrestrial Influences on Weather_, Billy McCormac (ed.), Colorado Associated University Press, Boulder, 145-160 (1983).

A radar technique is described that could prove useful in studying possible relationships between ionospheric variability and middle atmospheric dynamics. One specific example is presented (Balsley et al., 1982), which shows an observed correlation between short-term fluctuations in the auroral electrojet and variations in the zonal wind field near the mesopause.

AL-003
BALSLEY, B. B., M. Crochet, W. L. ECKLUND, D. A. CARTER, A. C. Riddle, and R. Garello. Observations of vertical motions in the troposphere and lower stratosphere using three closely-spaced ST radars. Preprint Volume, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society, Boston, 148-152 (1983).

No abstract.

AL-004
BALSLEY, B. B., M. Crochet, W. L. ECKLUND, D. A. CARTER, A. C. Riddle, and R. Garello. An ST radar experiment in Southern France during ALPEX. _ALPEX Newsletter_ 4:3 (1983).

No abstract.

AL-005
BALSLEY, B. B., W. L. ECKLUND, and K. S. GAGE. On the use of clear-air ST radars to observe winds, waves and turbulence in the troposphere and lower stratosphere. Preprint Volume, 5th Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Ontario, Canada. American Meteorological Society, Boston, 191-195 (1983).

No abstract.

AL-006
Böhringer, H., M. Durup-Ferguson, and D. W. FAHEY. Mobilities of various mass identified positive ions in helium, neon, and argon. _Journal of Chemical Physics_ 79:1974-1976 (1983).

The mobilities of several mass-identified positive ions in helium, neon, and argon buffer gases were measured in a flow drift tube apparatus as a function of E/N at 297 K. The systems studied were N_2O^4, NO_2^4, and SO_2^4 in He, H_2O^4, O_2^4, and N_2O^4 in Ne, and H_2O^4, H_3O^4, N_2O^4, NO_2^4, and SO_2^4 in Ar. The values obtained were compared to previous measurements and Langevin mobilities and were used to estimate the well depth of the ion buffer interaction potential.

AL-007

Böhringer, H., M. Durup-Ferguson, E. E. FERGUSON, and D. W. FAHEY. Collisional vibrational quenching of $O_2^+(v)$ and other molecular ions in planetary atmospheres. Planetary and Space Science 31:483-487 (1983).

New experimental techniques have yielded several thermal energy vibrational quenching rate constants for $O_2^+(v)$. Rates for quenching of $O_2^+(v=1)$ by O_2, N_2, Ar, CO_2, H_2, and CH_4 are 3(-10), 2(-12), 1(-12), 1(-10), 2.5(-12), and 6(-10) cm^3s^{-1} at 300 K. The quenching is somewhat faster for $O_2^+(v=2)$. The triatomic ions CO_2^+, NO_2^+, N_2O^+, SO_2^+, and H_2O^+ are all vibrationally deexcited with an efficiency greater than 10^{-3} in Ar or Ne collisions. A theoretical rationalization of the experimental results leads to the prediction that vibrational quenching in planetary atmospheres will generally be efficient, k > 1(-12) cm^3s^{-1} for almost all ion and neutral gas pairs.

AL-008

Böhringer, H., D. W. FAHEY, F. C. FEHSENFELD, and E. E. FERGUSON. The role of ion-molecule reactions in the conversion of N_2O_5 to HNO_3 in the stratosphere. Planetary and Space Science 31:185-191 (1983.

We have investigated the role of several ion-molecule reactions in the conversion of N_2O_5 to NHO_3. In the proposed conversion, an N_2O_5 molecule would react with an H_2O molecule clustered to an inert ion to produce two HNO_3 molecules. Subsequent clustering of an H_2O molecule to the inert ion would make the reaction catalytic. If such an ion-catalysed conversion of N_2O_5 to HNO_3 occurs, it would probably play a role in the stratospheric chemistry at high latitudes in winter. In this paper we present reaction rate constant measurements made in a flowing afterglow apparatus for hydrated H_3O^+, $H^+(CH_3CN)_m$ (m = 1,2,3), and several negative ions reacting with N_2O_5. Slow rate constants were found for these ions for hydration levels that are predominant in the stratosphere. With the known stratospheric ion density, these slow rate constants preclude significant N_2O_5 conversion by ion-molecule reactions.

AL-009

Burnett, C. R., and E. B. Burnett. OH Pepsios. Applied Optics (September 15, 1983).

An ultraviolet spectrometer of Pepsios design has been constructed and used for measurements of the vertical column abundance of atmospheric hydroxyl. Ground-based observations are made of the spectroscopic absorption of sunlight by OH at 3081.7 Å. The measurements are of relevance to the problem of stratospheric ozone. The spectrometer is a series arrangement of four pressure-scanned Fabry-Perot etalons with vernier spacer ratios. The spectral resolution of 0.06 cm^{-1} permits the identification and measurements of the sharp absorption feature from cool terrestrial OH against the solar background. The observations from Fritz Peak Observatory, Colorado, are presently contributing to a new data base on this atmospheric trace constituent which should be of importance in the understanding of middle atmospheric photochemical processes.

AL-010

CARTER, D. A., and B. B. BALSLEY. The summer wind field between 80 km-93 km observed by the MST radar at Poker Flat, Alaska (65°N). Journal of Atmospheric Sciences 39:2905-2915 (1982).

Results of an analysis of the summertime wind field between 80-93 km over Poker Flat, Alaska are presented. The data were obtained using the large, but as yet incomplete, MST radar at Poker Flat, and cover the periods 17 June-13 July 1979, and 22 June-22 July 1980. Zonal and meridional mean wind profiles and "tidal" components during these periods are examined and are compared with other observations at comparable latitudes as well as with current theoretical profiles. While our results agree reasonably closely with other observations and theory, some discrepancies exist and are discussed. In addition to the expected 8, 12 and 24 h components of atmospheric motions, we find strong evidence for a 16 h component, particularly during the 1979 data period. In addition, we show examples of the average power spectrum of wind fluctuations from 3 min to 8 days. These spectra not only show the expected "tidal" peaks, but show also that the spectral energy density is continuous between the shortest (8 h) tidal period and the shortest observed period (3 min), falling off with an $f^{-5/3}$ power law. Some aspects of these spectral results are discussed, including the possible processes that may operate to produce such a spectral shape.

AL-011

Cicerone, R., S. Walters, and S. C. LIU. Nonlinear response of stratospheric ozone column to chlorine injections. Journal of Geophysical Research 88:3647 (1983).

With a reasonably complete and up-to-date photochemical model of the stratosphere, we find that the calculated stratospheric ozone-column response to chlorine injections is highly nonlinear. The model calculations assume that the background inorganic (or odd) chlorine, ClX, is due to CH_3Cl and CCl_4. Additional

ClX is added to the stratosphere by varying input fluxes of CCl_2F_2 and CCl_3F. The sensitivity, $\Delta O_3/\Delta ClX$, of the stratospheric O_3 column to added ClX is relatively small for ClX $\lesssim$ 3 ppb or $\Delta ClX \lesssim$ 2 ppb; slight ozone increases with ClX are possible over a limited range of ClX if the formation of chlorine nitrate proceeds rapidly. This may have important implications for total ozone-column trend assessment. As ClX increases beyond 3 ppb, the stratospheric O_3 column decreases with ClX increasingly rapidly. This marked departure from the linearity calculated in past years is largely due to presently accepted faster rates of reaction of OH with HNO_3, HNO_4, HO_2, and H_2O_2. If stratospheric ClX increases to about 9 ppb due to continued usage of CCl_2F_2, CCl_3F, and CH_3CCl_3, the stratospheric O_3 column depletion is calculated to be 6.7-9.0%. Principal uncertainties in these calculations, including the rate of formation of chlorine nitrate, the products of its photolysis, and the present day mixing ratio of ClX are discussed. Calculated ozone decreases due to increased N_2O concentrations are also presented.

AL-012

Dobler, W., W. Federer, F. Howorka, W. Lindinger, M. Durup-Ferguson, and E. E. FERGUSON. Vibrational relaxation of NO^+(v) ions in neutral collisions. Journal of Chemical Physics 79:1643 (1983).

No abstract.

AL-013

Dupeyrat, G., B. R. Rowe, D. W. FAHEY, and D. L. ALBRITTON. Diagnostic studies of venturi inlet for flow reactors. International Journal of Mass Spectrometry and Ion Physics 44:1-18 (1982).

Venturi inlets allow the injection of mass-selected ions into a flowing-afterglow apparatus for measurements of reaction rate constants. Diagnostic measurements for several inlets have been made in a flowing-afterglow apparatus and in a rarefied wind-tunnel. In the former, the venturi effect of each inlet was measured. In the latter, a visualization of the flow was obtained both upstream and downstream of each inlet. The results show clear differences between inlet designs and suggest general rules for their use.

AL-014

Durup-Ferguson, M., H. Böhringer, D. W. FAHEY, and E. E. FERGUSON. Enhancement of charge-transfer reaction rate constants by vibrational excitation at kinetic energies below 1 eV. Journal of Chemical Physics 79:265-272 (1983).

A number of molecular ion charge-transfer reactions with neutral molecules have been studied in a flow-drift tube system as a function of average kinetic energy from thermal to ~ 1 eV. Varying the buffer gas gives an independent control of the vibrational state distribution of the ions. The reactions include the charge transfer of N_2O^4, NO_2^4, SO_2^4, and H_2O^4 ions with NO and CO_2^4 ions with NO, O_2, CH_4, and Xe. For CO_2^4 reaction with CH_4 and Xe the charge transfer occurs at near the collision rate and has little energy dependence and no measureable vibrational dependence. In every other case, where the rate constants are less than the collision rate constants, large enhancements result from vibrational excitation of the ions. The presence of ion vibrational excitation is demonstrated by the addition of a quenching gas to the flow-drift tube. In the low energy (near-thermal) regime where reaction is presumed to occur via long-lived intermediate complex formation, the reaction rate constants are increased by vibrational energy and decreased by kinetic energy. In the higher energy range where the rate constants increase with increasing kinetic energy, vibrational energy also increases the rate constants and to a comparable extent.

AL-015

ECKLUND, W. L., K. S. GAGE, B. B. BALSLEY, R. G. STRAUCH, and J. L. GREEN. Vertical wind variability observed by VHF radar in the lee of the Colorado Rockies. Monthly Weather Review 110:1451-1457 (1982).

During March 1981 the Sunset and Platteville VHF clear-air radars located in Colorado to the east of the continental divide observed vertical winds continuously over a three-week period. The vertical winds at these locations contain fluctuations with periods from a few minutes to several hours and with magnitudes ranging up to a few meters per second. The Sunset radar, which is located in the foothills, observed systematically larger vertical velocities than the vertical velocities observed by the Platteville radar, which is located on the plains, some 60 km to the east. Although periods of enhanced vertical wind activity were observed to occur at the same time at both sites, attempts to correlate vertical wind structures over the two sites in detail were generally not successful. The magnitude of vertical velocity fluctuations seen by both radars show large day-to-day variations with "active" periods alternating with "quiet" periods. An examination of upper level maps reveals that the occurrence of active and quiet periods are linked to the large-scale wind field. During the March experiment the magnitude of the vertical velocity variance was well correlated with the 500 mb zonal (west) wind.

AL-016

ECKLUND, W. L., K. S. GAGE, B. B. BALSLEY, R. G. STRAUCH, and A. C. Riddle. Vertical wind observations using VHF clear-air radars. Preprint Volume, 5th Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Ontario, Canada. American Meteorological Society, Boston, 199-204 (1983).

No abstract.

AL-017

FERGUSON, E. E. Spin non-conservation in low energy molecular charge-transfer reactions. Chemical Physics Letters 99:89 (1983).

The reaction $H_2O^+(^2B) + NO_2(^2A) \rightarrow H_2O(^1A) + NO_2^+(^1\Sigma)$ occurs at near the collision rate constant, 1.2×10^{-9} cm^{3}s^{-1}, in spite of the fact that the reactants produce both a singlet and a triplet state and the products correlate only with the singlet state. This would be expected to yield a statistical weight factor of $\frac{1}{4}$ to be multiplied by the collision rate constant to obtain the maximum charge-transfer rate constant. The triplet products of the charge transfer are clearly endothermic. The singlet-triplet intersection has not been identified but the available information about the singlet and triplet states of the intermediate protonated nitric acid molecule is discussed. Four other examples of apparent "spin violation" charge-transfer reactions have been noted, $H_2O^+ + NO$, $N_2O^+ + NO$, $CO^+ + NO$ and $CH_4^+ + O_2$.

AL-018

GAGE, K. S. Impact of new technology on observations of waves and turbulence in the free atmosphere. Preprint Volume, 6th Symposium on Turbulence and Diffusion, Boston, Massachusetts, March 22-25, 1983. American Meteorological Society, Boston, 198-200 (1983).

No abstract.

AL-019

GAGE, K. S., and B. B. BALSLEY. Advances in remote sensing of the atmosphere. Reviews of Geophysics and Space Physics 21:955-965 (1983).

No abstract.

AL-020

GAGE, K. S., J. L. GREEN, B. B. BALSLEY, W. L. ECKLUND, R. G. STRAUCH, and K. J. RUTH. Comparison of radar reflectivities between the Sunset and Platteville ST radars. Preprint Volume, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society, Boston, 129-134 (1983).

No abstract.

AL-021

GAGE, K. S., and G. C. REID. Coherent annual and interannual variations in temperature and height fields in the tropical troposphere and lower stratosphere. Geophysical Research Letters 9:1199-1201 (1982).

Radiosonde observations of temperature and height fields for 1953-1969 have been analyzed for five tropical Pacific stations (Ponape, Guam, Yap, Eniwetok and Koror). These data have been combined to form monthly means averaged over all years and stations and annual means averaged over all stations. The analysis reveals a coherent annual variation consistent with the well-known annual temperature wave in the tropics, i.e., a tropospheric cycle with warmest temperatures around April and May, and a roughly out-of-phase lower stratospheric cycle with coldest temperatures during the period December-May. Comparing year-to-year variations in the tropospheric and lower stratospheric thermal fields, we find the out-of-phase relationship preserved. Periods of warm anomalies in the troposphere coincide with periods of cold anomalies in the stratosphere and vice versa. These observations are consistent with annual and interannual variations in the intensity of the Hadley cell circulation.

AL-022
  GAGE, K. S., and T. E. VANZANDT. The simulation of intermittent clear air turbulence by a Monte Carlo technique. Preprint Volume, 6th Symposium on Turbulence and Diffusion, Boston, Massachusetts, March 22-25, 1983. American Meteorological Society, Boston, 85-88 (1983).

  No abstract.

AL-023
  Garcia, R. R., and S. SOLOMON. A numerical model of the zonally averaged dynamical and chemical structure of the middle atmosphere. <u>Journal</u> <u>of</u> <u>Geophysical</u> <u>Research</u> 88:1379 (1983).

  A two-dimensional, time-dependent model has been constructed to study the zonally averaged structure of the middle atmosphere (16-116 km) allowing interaction among dynamics, radiation and photochemistry. The zonally averaged dynamics are governed by a stream function equation for the residual Eulerian meridional circulation wherein the effects of wave transcience and dissipation have been neglected. The resulting circulation is thus driven by diabatic heating and cooling, with Rayleigh friction introduced to balance the momentum budget. The temperature structure is computed from the zonal mean thermodynamic equation, while the appropriate continuity equations are solved to determine the distribution of the various chemical species and families. In the chemical continuity equations, two types of eddy transport processes are present in addition to the transport by the residual Eulerian circulation. Small-scale disturbances are assumed to produce turbulent mixing which is modeled in terms of horizontal and vertical diffusion coefficients, while steady state planetary waves give rise to fluxes which are expressed in terms of observed wave structure and the photochemical lifetime of the species transported. The circulation, temperature structure, and distribution of chemical constituents obtained with the model are for the most part in satisfactory agreement with observations. In particular, the direct, equator-to-pole circulation computed for the stratosphere seems to be capable of explaining the major features of the distribution of trace constituents there, although the effect of the Fickian diffusion included in the model is important in determining the magnitude of gradients.

AL-024
  GOLDAN, P. D., W. C. KUSTER, D. L. ALBRITTON, F. C. FEHSENFELD, P. S. Connell, R. B. NORTON, and B. J. Huebert. Calibration and tests of the filter-collection method for measuring clean-air, ambient levels of nitric acid. <u>Atmospheric</u> <u>Environment</u> 17:1355-1364 (1983).

  A portable permeation tube based system has been developed for the field calibration of nitric acid vapor collection on Nylon filters during actual atmospheric sampling. Extensive testing has been undertaken to determine the effects of transfer line materials, the uptake of nitric acid on the filter holder apparatus, the linearity of dilution of the nitric acid effusing from the permeation tube source achievable and the effects of the permeation of gases, other than nitric acid, on the permeation tube calibration. Data demonstrating significant uptake of HNO_3 on commonly used materials are given, together with specific recommendations on the use of materials to avoid such problems. Nitrogen dioxide is shown to be a significant contaminant of the HNO_3 permeation tubes used requiring corrections of the order of 15% Nitric acid "spiking" during actual field sampling of clean tropospheric air at a remote site in the Rocky Mountains west of Boulder, Colorado demonstrated agreement between the measured Nylon filter nitrate loading and the calculated loading to +0.1, -0.4 µg at the 60% confidence level. At the atmospheric sampling rate used of 120 std L min^{-1}, these limits correspond to +5, -20 pptv for a one hour sampling time, with proportionately smaller uncertainties on the mean HNO_3 mixing ratio for longer sampling times.

AL-025
  GREEN, J. L., W. L. CLARK, J. M. WARNOCK, and K. J. RUTH. Absolute calibration of MST/ST radars. Preprint Volume, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society, Boston, 144-14 (1983).

  No abstract.

AL-026
  GREEN, J. L., K. S. GAGE, and B. B. BALSLEY. A reexamination of the pulse length dependence of back-scattered power observed by VHF radar at vertical incidence. Preprint Volume, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society, Boston, 141-143 (1983).

  No abstract.

AL-027

HERNANDEZ, G. Solar, geomagnetic and long term effects on thermospheric neutral kinetic tempertures at midlatitude. Advances in Space Research 3:129-136 (1983).

Measurements of midlatitude thermospheric neutral kinetic temperatures obtained from 1972 to 1979 have been used to investigate the effects of solar and geomagnetic activity, as well as long term effects, on the thermosphere. With these data a simple power law relationship between the temperature and solar activity (expressed as the 2.8 GHz solar radio flux) has been found to give a high correlation. In addition, a linear relationship between temperature changes and geomagnetic activity (expressed as Ap), as well as annual and semiannual effects have been found. The annual variation is found to be indistinguishable in phase from the annual variation of the solar declination angle. The present four parameter formulation gives a better fit to the data than is obtained with available empirical models of the thermosphere, and this has allowed us to investigate the properties and postulates of some of these models.

AL-028

Huebert, B. J., R. B. NORTON, M. J. Bollinger, D. D. Parrish, C. Hahn, Y. A. Bush, P. C. Murphy, F. C. FEHSENFELD, and D. L. ALBRITTON. Gas phase and precipitation acidities in the Colorado mountains. In Acid Rain, A Water Resources Issue for the 80's, R. Herrman and A. I. Johnson (eds.), American Water Resources Association, Bethesda, Maryland, 17-23 (1982).

For the past few years, both the gas phase concentrations of nitric acid, its precursors, and nitrate aerosols and the precipitation concentrations of nitrate were measured at Niwot Ridge, a remote area field site located at 3 km elevation in the Colorado mountains west of the Denver metropolitan area. The measurements were made using a variety of techniques: filter collection, ion chromatographic analysis, direct pH and conductivity determinations, and chemiluminescence detection. An extensive wind speed/wind direction network, coupled with trajectory analyses, provided meteorological support. The prevailing winds at the site are from the west, although occasionally the wind is from the east, across the metropolitan area in that direction. Correlations between the wind direction and the acidity levels, both in the air and in the preparation, show that, despite the fact that east winds are atypical, the acidic components accompanying these winds are the likely major source of the relatively high acid deposition that occurs at the site. The observed nitric acid/precursor correlations are consistent with the current picture of the transformation chemistry. During the winter of 1980/81, it was shown that snow scavenges nitric acid and nitrate very efficiently.

AL-029

KLEY, D., A. L. SCHMELTEKOPF, K. KELLY, R. H. WINKLER, T. L. THOMPSON, and M. MCFARLAND. The U-2 Lyman-alpha hygrometer results from the 1980 Panama experiment. In The 1980 Stratospheric-Tropospheric Exchange Experiment, A. P. Margozzi (ed.), NASA Tech. Memo 84297, 85-125 (1983).

The U-2 Lyman-alpha hygrometer is described, its accuracy and precision are assessed in detail, and results obtained with it during the 1980 Tropospheric/Stratospheric Water Vapor Exchange Experiment are reported.

AL-030

LIU, S. C., M. MCFARLAND, D. KLEY, O. Zafiriou, and B. Huebert. Tropospheric NO_x and O_3 budgets in the equatorial Pacific. Journal of Geophysical Research 88:1360-1368 (1983).

By combining the results of model calculations and simultaneous measurements of O_3, NO, HNO_3, particulate NO_3^-, and meteorological parameters in the mid-Pacific, we have investigated the budget and photochemistry of near surface atmospheric ozone and odd nitrogen. The observed decrease of O_3 toward the Intertropical Convergence Zone is consistent with the transport of O_3, from higher latitude and a photochemical sink for O_3 by the reaction between H_2O and $O(^1D)$. The total deposition flux of odd nitrogen deduced from the data is about 1.3×10^9 cm^{-2} s^{-1}, or 5 MT(N)/yr averaged globally. Most of the deposition flux is due to HNO_3 and particulate NO_3^-. This deposition flux is probably representative of values over most of the Pacific because the HNO_3 and particulate NO_3^- densities measured over the Pacific during the GAMETAG experiments are consistent with our values. Since the residence time of odd nitrogen in the lower troposphere is short, a widely distributed, diffuse source of odd nitrogen is required to balance the deposition flux. It seems that the NO formed by cloud to cloud lightning in the tropical upper troposphere is the most likely source.

AL-031

Mount, G. H., D. W. Rusch, J. M. Zawodny, J. F. NOXON, C. A. Barth, G. J. Rottman, R. J. Thomas, G. E. Thomas, R. W. Sanders, and G. M. Lawrence. Measurements of NO_2 in the earth's stratosphere using a limb scanning visible light spectrometer. Geophysical Research Letters 10:265 (1983).

NO_2 densities determined from the limb scanning visible light spectrometer on board the Solar Mesosphere Explorer spacecraft are reported for winter 1981/82 in the altitude region 28-40 km. The observational technique utilizes the photoabsorption by NO_2 of Rayleigh scattered sunlight in the 440nm spectral region. The NO_2 density varies from pole to pole and shows large variations at high northern latitudes during the winter months which are related to both the temperature and flow of air near 30 km.

AL-032

Nastrom, G. D., and K. S. GAGE. A brief climatology of vertical air motions from MST radar data at Poker Flat, Alaska. Preprint Volume, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society, Boston, 135-140 (1983).

No abstract.

AL-033

NORTON, R. B., J. M. Roberts, and B. J. Huebert. Tropospheric oxalate. Geophysical Research Letters 10:517-520 (1983).

The existence of oxalate $(COO)_2^=$ in tropospheric aerosols and in precipitation has been demonstrated using ion chromatography. Mixing ratios have been observed up to 50 pptv in air samples and 0.3 ppm in precipitation. Correlation of airborne oxalate with airborne nitrate suggests a pollution source.

AL-034

NOXON, J. F., W. R. HENDERSON, and R. B. NORTON. Stratospheric NO_2: 3, The effects of large-scale horizontal transport. Journal of Geophysical Research 88:5240 (1983).

This paper discusses several extended sets of measurements of stratospheric NO_2 near 20°N and in the region 40°N-70°N. The principal concern at high latitude is with the relation between the NO_2 column abundance and quasi-horizontal flow patterns in the stratosphere near 30 km. It appears that NO_2 can serve as a tracer of such flow, particularly at higher latitude in winter when the flow is rapid in comparison with the rate of photochemical readjustment. When polar air, originally low in NO_2, is delivered to lower latitude, one observes a drop in NO_2 abundance; the drop is less the lower the latitude of observation owing to the greater time available for NO_2 to be released from the polar night storage species. A study of total ozone column abundance and the flow at 100 mbar indicates a close relation between them similar to that for NO_2 at higher altitude.

AL-035

Parrish, D. D., P. C. Murphy, D. L. ALBRITTON, and F. C. FEHSENFELD. The measurement of the photodissociation rate of NO_2 in the atmosphere. Atmospheric Environment 17:1365-1379 (1983).

The photodissociation rate of NO_2 by sunlight, j_{NO_2}, has been measured as a function of solar zenith angle, χ, at a nonurban field site in the Colorado mountains under a variety of sky conditions. These results indicate that

$$j_{NO_2}(\chi) = [0.01305 \exp(-0.360 \sec\chi)] \pm 7\% \ s^{-1},$$

for summertime, clear skies, small aerosol loadings, low-albedo background and 3 km surface elevation. The band defined by the above uncertainty contains 95% of our measurements. These data are compared to previous theoretical and experimental values that have been adjusted, using theoretical sensitivity factors, to correspond to the above site and atmospheric characteristics. The agreement is good, within 7%. However, it is noted that, had the theoretical calculations used the most recent $NO_2 \rightarrow NO + O$ quantum-yield data (Harker et al., 1977), the agreement would not be satisfactory, thereby suggesting the need for further NO_2 quantum-yield studies. The cloudy-day data are compared to the expectations of an isotropic-filter cloud-effects model, which is found to be a poor general description. A phenomenological cloud-effects model, which offers some improvement, is proposed.

AL-036
  REID, G. C., and K. S. GAGE. Solar variability and the height of the tropical tropopause. <u>Solar-Terrestrial Influences on Weather and Climate</u>. Billy McCormac (ed.), Colorado Associated University Press, Boulder, 569-579 (1983).

  The height of the tropopause at tropical Pacific stations shows a regular annual variation and an interannual variation that has been positively correlated with the Zurich sunspot number during the period 1953-69. We propose that the annual variation is a response to the annual variation of solar radiation in the tropics, and that the interannual variation reflects a corresponding interannual variation in the Sun's radiative output. The mechanism invokes small changes in surface temperature, leading to changes in absolute humidity, and in the intensity of deep convective cells in the troposphere. The magnitude of the observed interannual variability in tropopause height can be explained by this mechanism if the Sun's radiative output varies on a scale of a few parts per thousand over a time scale of the order of the 11-yr cycle.

AL-037
  Riddle, A. C., K. S. GAGE, and B. B. BALSLEY. An algorithm to monitor continuously the tropopause height using a VHF radar. Preprint Volume, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society, Boston, 153-155 (1983).

  No abstract.

AL-038
  SOLOMON, S. Minor constituents in the stratosphere and mesosphere. <u>Reviews of Geophysics and Space Physics</u> 21:276 (1983).

  This paper is intended to be a brief survey of research in the field of middle atmosphere chemistry from 1979 to 1982. The possibility of anthropogenic perturbation to the stratospheric ozone layer, particularly as a result of chlorocarbons, remains a subject of interest, and has been studied with increasingly detailed models during this period. A great deal of data on the distributions of many important species have been obtained, leading to substantial progress in our understanding of the processes controlling the photochemistry of minor species in the middle atmosphere.

AL-039
  SOLMON, S. The possible effects of translationally excited nitrogen atoms on lower thermospheric odd nitrogen. <u>Planetary and Space Science</u> 31:135 (1983).

  In the quiet lower thermosphere, photolysis of N_2 produces translationally excited $N(^4S)$ and $N(^2D)$ atoms. A fraction of these $N(^4S)$ atoms may react rapidly with O_2 while still translationally hot. This results in substantially larger calculated NO densities than those obtained if tranlational excitation is not considered. The sensitivity of the calculated NO density in the lower thermosphere to this process is examined.

AL-040
  SOLOMON, S., E. E. FERGUSON, D. W. FAHEY, and P. J. Crutzen. On the chemistry of H_2O, H_2 and meteoritic ions in the mesosphere and lower thermosphere. <u>Planetary and Space Science</u> 30:1117 (1982).

  In the Earth's lower thermosphere and mesosphere, water vapor is photodissociated by absoption of Lyman alpha radiation. The hydrogen containing free radicals produced by this process lead to the formation of molecular hydrogen. Therefore, very small water vapor mixing ratios are expected at high altitudes, particularly in summer, when photolysis is especially rapid. We present one and two-dimensional model calculations regarding the distribution of H_2O and H_2 in the upper atmosphere. The ion chemistry of meteor ions in the lower thermosphere is also examined and it is shown that silicon ion densities can be used to infer water vapor concentrations near 100 km. The water vapor mixing ratios obtained are generally well below one part per million and are in good agreement with the model calculations.

AL-041
  SOLOMON, S., and R. R. Garcia. On the distribution of nitrogen dioxide in the high latitude stratosphere. <u>Journal of Geophysical Research</u> 88:5497 (1983).

  A time dependent two-dimensional model has been used to study the behavior of nitrogen species in the atmosphere. The model employs a residual mean meridional circulation for the transport of photochemical

8

species, and this transport yields large column abundances for NO_x $(N + NO + NO_2 + NO_3 + 2 \times N_2O_5 + HNO_4)$ at high latitudes, with the altitude of maximum density occurring in the lower stratosphere. New temperature dependent absorption cross sections are employed for N_2O_5. It is shown that this photochemical-dynamical formulation results in the conversion of most of the stratospheric NO_x to N_2O_5 at high latitudes in winter, yielding low NO_2 column abundances there, in agreement with observations. Calculated seasonal and diurnal variations in NO_2 are also shown to be comparable to observations, even at high latitudes. The effects of departures from zonally symmetric flow on NO_2 abundance are examined and found to be consistent with observations.

AL-042
  SOLOMON, S., and R. R. Garcia. Simulation of NO_x partitioning along isobaric parcel trajectories. Journal of Geophysical Research 88:5497 (1983).

A numerical study is presented of the chemistry of NO_x $(NO + NO_2 + NO_3 + 2 \times N_2O_5)$ in air parcels assumed to travel on constant pressure surfaces for a period in early February 1977. Airflow was observed to be stable and largely barotropic during this period. Strong coupling between photochemical and dynamical effects is found to play an important role in determining the distributions of these species. Comparison of model results to observations of the total column abundance of NO_2 (Noxon, 1979) yields good agreement and implies that attention should be given to dynamical conditions when comparing model calculations and observations of odd nitrogen species in the stratosphere.

AL-043
  SOLOMON, S., G. C. REID, D. W. Rusch, and R. J. Thomas. Mesospheric ozone depletion during the solar proton event of July 13, 1982 Part II. Comparison between theory and measurements. Geophysical Research Letters 10:257 (1983).

The solar proton event of July 13, 1982 was the largest to date in the current solar cycle. Several smaller events also occurred in 1982, including one on December 8, 1982. Proton fluxes observed by the NOAA-6 satellite have been used to calculate ionization rates during these two events. This ionization leads to the production of odd hydrogen radicals $(H+OH+HO_2)$ which catalytically destroy odd oxygen in the mesosphere and stratosphere. A one-dimensional time-dependent model has been used to calculate the percentage change in ozone resulting from these events. The calculated ozone depletion is compared to that observed by the Solar Mesosphere Explorer (SME) satellite. Keywords: Ozone, mesosphere, solar protons

AL-044
  SOLOMON, S., D. W. Rusch, R. J. Thomas, and R. S. Eckman. Comparison of Mesospheric ozone abundances measured by the solar mesosphere explorer and model calculations. Geophysical Research Letters 10:249 (1983).

Ozone observations in the mesosphere obtained by the near infrared and ultraviolet spectrometers onboard the Solar Mesosphere Explorer (SME) satellite are compared to two dimensional model calculations for the month of January. In general, the model calculated abundances are somewhat smaller than those measured, but exhibit similar trends with respect to altitude and latitude. The possible causes of discrepancies are explored.

AL-045
  VANZANDT, T. E., and R. A. Vincent. Is VHF Fresnel reflectivity due to low frequency buoyancy. Preprint Volume, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society, Boston, 126-138 (1983).

No abstract.

AL-046
  Viehland, L. A., and D. W. FAHEY. The mobilities of NO_3^-, NO_2^-, NO^+, and Cl^- in N_2: A measure of inelastic energy loss. Journal of Chemical Physics 78:435-441 (1983).

Ion mobility measurements were made for NO_2^-, NO_3^-, NO^+, and Cl^- ions drifting in N_2. The measurements were made in a flow-drift tube apparatus at 300 K as a function of E/N. The results were compared to previous measurements made at low E/N as a function of temperature. The comparison was made at the same ion-neutral collision temperatures as calculated from the Wannier equation. The results agree at low collision temperatures (T~300 K) but disagree at high collision temperatures (T$\geq$400 K). This disagreement

or "mobility difference" is attributed to an inelastic energy loss channel for the ion-neutral collisions in the flow-drift tube measurements. Using recently developed theory for ion-swarm phenomena, the differences in mobilities have been used to calculate the dimensionless ratios of inelastic energy loss to momentum transfer in the ion-neutral collision systems.

AL-047
WESTWATER, E. R., M. T. DECKER, A. Zachs, and K. S. GAGE. Ground-based remote sensing of temperature profiles by a combination of microwave radiometry and radar. Journal of Applied Meteorology 22:126-133 (1983).

This paper describes the results of a three-week experiment in which ground-based microwave radiometric measurements were combined with VHF radar measurements of tropopause height to yield vertical temperature profiles. Several algorithms to derive tropopause height are presented and their results are compared with radiosondes. The best of the algorithms yields radar versus radiosonde rms differences of ~0.65 km. By the use of the combined radar-radiometric method, improvements were obtained in rms temperature accuracy of as much as 2.0 K rms over the pure radiometric technique.

AL-048
WEINSTOCK, J. Heat flux induced by gravity waves. Geophysical Research Letters 10:165-167 (1983).

A derivation is given of the heat flux induced by large amplitude gravity waves; the case where nonlinear or turbulent damping exceeds molecular damping. This case is typical of the middle atmosphere. The derivation is based on a simple algorithm for converting the linear dispersion relation for gravity waves into a nonlinear one, and generalizes a recent derivation by Walterscheid. The derived heat deposition flux is shown to cause local cooling where the waves are close to saturation, but could cause heating where the waves are far from saturation. It is then proven that the heat flux is related to the diffusivity and to the wave momentum deposition flux by simple expressions. Hence, knowledge of one transport coefficient is practically equivalent to knowledge of the other two. The derivation is limited to waves that have some randomicity.

AL-049
WEINSTOCK, J. Simplified derivation of an algorithm for nonlinear gravity waves. Journal of Geophysical Research (1983).

A simplified proof is given that the linear dispersion relation for gravity waves is converted into a nonlinear dispersion relation by making the replacement

$$(\omega_k - k \cdot u_o) \rightarrow (\omega_k - k \cdot u_o - id_w) \ ,$$

where ω_k is the wave frequency, k is the wavevector, u_o is the mean flow, and d_w is a nonlinear damping rate explicitly determined by the RMS wave velocity. This derivation differs from a previous one in its brevity as well as relative simplicity. The purpose is to present a derivation that does not require previous familiarity with the statistical theory of strong nonlinear interactions, and to more explicitly reveal the underlying assumptions and approximations. A substance difference is that a spacetime average is used instead of an ensemble average and the theory is no longer restricted to random phased waves. The physical significance of d_w is then elucidated and related to recent experimental observations. Limitations of the derivation are to a quasistationary, homogeneous state in which u_o and other average quantities vary but slowly, to wavelengths satisfying $2k_z H \gg 1$, and to wave amplitudes that are too large to be treated by weak mode-coupling theories.

AR-001
ACKERMANN, G.R. Means and standard deviations of horizontal wind components. Journal of Applied Meteorology 22(5):959-961 (1983).

An algorithm is presented that computes a measure of horizontal wind dispersion. The algorithm features a compact, machine economic structure that removes wind direction scale discontinuities. By requiring only one pass through the input data, the larger storage and extra time needed for a two pass algorithm are eliminated. This is especially helpful in real time data acquisition environments. Data are included for comparison of the described algorithm and two standard, less machine efficient algorithms.

AR-002
ANGELL, J. K., and J. KORSHOVER. Global temperature variations in the troposphere and stratosphere, 1958-1982. Monthly Weather Review 111:901-921 (1983).

A network of 63 well-distributed radiosonde stations has been used to estimate mean-annual temperature variations at the surface and for 85-30 kPa (850-300 mb), 30-10 kPa, 10-5 kPa, 10-3 kPa, and surface-10 kPa layers for five climatic zones, both hemispheres, and the world for the interval 1958-81. At the surface and in the 85-30 kPa layer there was global cooling of about 0.5°C between 1958 and about 1970, and global warming since, with 1980 and 1981 values approximately 0.1°C warmer than observed in 1958 and 1959. However, an update using seasonal data indicates appreciable cooling again between the northern springs of 1981 and 1982. In the 30-10 kPa layer there has been slight global cooling during most of the interval 1958-81, resulting in an increase in lapse rate in the 85-30 and 30-10 kPa layers during the last decade. In the middle and high stratosphere (26-55 km), Northern Hemisphere rocketsonde data suggest a 3-5°C cooling between 1970 and 1976, but little temperature change since. There is evidence for an 0.3°C decrease in Northern Hemisphere surface temperature following the Agung eruption in 1963, as well as at least 1.0°C temperature increase in the low stratosphere of the tropics, but no convincing evidence that the eruptions of Fuego in 1974 or St. Helens in 1980 affected either tropospheric or stratospheric temperatures. Between 1958 and 1981, the correlation between sea-surface temperature (SST) in the equatorial eastern Pacific, and global temperature for the surface-10 kPa layer, is a significant 0.58 at a lag of two seasons, SST leading. There is some indication that, in the tropics, this lag increases slightly with distance from the equator and height in the troposphere. During the past decade there has been a close (inverse) relation between the area of the 30 kPa (300 mb) north polar vortex and 85-30 kPa temperature. During 1958-81 the departure from the mean of the seasonal 85-30 kPa temperature in north temperate latitudes averaged -0.4°C three seasons after cool SST in the equatorial eastern Pacific when the quasi-biennial oscillation (QBO) at 5 kPa in the tropics was in the eastwind phase, and 0.2°C three seasons after warm SST when the QBO was in the westwind phase. Inasmuch as SST has warmed through 1982, and the QBO east wind maximum at 5 kPa occurred in mid 1982, this relation would imply a relatively warm north-temperate troposphere in 1983.

AR-003
BARRETT, E. W., C. C. VAN VALIN, and D. L. WELLMAN. A technique for calculating small-particle scavenging rates in clouds using measured data. EOS 63(45):896 (1982).

Using the continuity equation for particles together with the assumptions of: (a) steady state; (b) a linear vertical-velocity profile from the sub-cloud layer to the measurement point; and (c) a size-independent scavenging rate, we have developed a procedure for calculating the rate at which small interstitial particles are scavenged by cloud droplets. The required measured data are: (a) the number concentration of particles at cloud base and at a point inside the cloud; (b) the height above cloud base of the in-cloud measuring point; and (c) the verical velocity near cloud base and near the interior point. We tested the scheme on data acquired on an instrumented meteorolgoical tower during an upslope-cloud episode on 11 May 1982. Particle and cloud-drop size spectra were acquired with PMS optical particle spectrometers. Vertical-velocity data were obtained from 3-D anemometers on the tower. For this quasi-steady stratus cloud, the calculated scavenging rate is in reasonable agreement with theoretical values. The particle size distributions that were measured validated assumption (c) above; the shapes of the distributions did not change appreciably with height above cloud base even though the total particle count decreased by a factor of about 20.

AR-004
Bergen, J. B., B. A. HUTCHISON, R. T. MCMILLEN, Jr., A. D. Ozment, and G. J. Gottfried. Observations on the relation of shortwave reflectivity of recently deposited snow to its physical properties. Journal of Climate and Applied Meteorology 22(2):193-200 (1983).

The integrated albedo for solar radiation in the 0.4-μm to 0.7-μm wave-length range was measured near noon over a wet snow cover before and after a new snowfall. Observed values were compared with those estimated from measurements of surface density, air permeability and the total to diffuse flux ratio by means of five models described in the literature and by using empirical correlations to estimate grain size. The models yield widely divergent results. The model with the best apparent performance shows an rms error of 0.02 with no particular bias. With one exception, however, the remaining models yield overestimates. Albedos calculated from samples taken from differing surface layers and variation of the prediction errors with the snow accumulation pattern were compared. Results suggest that a major source of error is the large depth interval sampled by the surface layer measurement technique as compared with the thickness of the surface layer of snow in which the bulk of absorption and scattering occur.

AR-005

BOATMAN, J. F., and A. H. Auer, Jr. The role of cloud top entrainment in cumulus clouds. Journal of the Atmospheric Sciences 40(6):1517-1534 (1983).

The entrainment process and its resultant effects on the microphysics and dynamics within cumuli are not yet clearly understood. This research was undertaken to discover the role which cloud top plays in the entrainment process and to determine whether observed downdraft magnitudes could be explained on the basis of evaporative cooling. An instrumented King Air research aircraft was used to acquire thermodynamic, microphysical and dynamical data within and near cumulus clouds of the high plains and midwestern United States. Temperature and liquid water content measurements made within the clouds were used to discover the source for any entrained air via a thermodynamic treatment intially pursued by Dufour (1956), and later expanded by Paluch (1979) and Betts (1982). The entrainment source regions found were either at or above the aircraft sampling level in 78 of the 87 cases examined. It was found that the environment within 20 mb of cloud top was the source for entrained air in these 78 cases. Evaporative cooling could not effectively transport air from above to the sampling level in the nine cases where entrained air from below the aircraft sampling level was measured. Vertical velocity measurements acquired in the observed clouds were compared with those predicted by evaporative cooling, as suggested by Squires (1958b). It was concluded that evaporative cooling could adequately explain the magnitude of the observed downdrafts in the 51 cases where a comparison between the predicted and observed downdraft magnitude was possible.

AR-006

BODHAINE, B. A., and J. M. HARRIS. Geophysical Monitoring for Climatic Change, No. 10: Summary Report 1981, 158 pp. (1982).

No abstract.

AR-007

BODHAINE, B. A., J. J. DELUISI, J. HARRIS, and R. Castillo. Light scattering, condensation nuclei, and air mass trajectories at Whiteface Mountain: Summer 1982. NOAA-DR-ERL-ARL-3 (PB84-104363), 69 pp. (1983).

An experiment to measure the effects of anthropogenic aerosols on clouds and solar radiation was conducted during the summers of 1981 and 1982 at Whiteface Mountain, NY. This report presents light-scattering and condensation nucleus data for the summer of 1982 in graphical and tabular form. In addition, 10-day back trajectories for which Whiteface Mountain is the destination are presented for the same time period.

AR-008

BRIGGS, G. A. Discussion of "Application of two-thirds law to plume rise from industrialized sources." Atmospheric Environment 17:1034 (1983).

No abstract.

AR-009

Britter, R. E., J. C. R. Hunt, G. L. Marsh and W. H. SNYDER. The effects of stable stratification on turbulent diffusion and the decay of grid turbulence. Journal of Fluid Mechanics 127:27-44 (1983).

Experiments are described in which a grid is towed horizontally along a large tank filled first with water and then with a stably stratified saline solution. The decay rates of the r.m.s. turbulent velocity components (w',v') perpendicular to the mean motion are measured by a 'Taylor' diffusion probe and are found to be unaffected by the stable stratification over distances measured from 5 to 47 mesh lengths (M)

downstream, and over a range of Froude number U/NM of ∞ and 8.5 to 0.5, U being the velocity and N the buoyancy frequency. The Reynolds number Mw'/μ of the turbulence was about 10^3, where μ is the kinematic viscosity. The vertical velocity fluctuations produced near the grid were reduced by the stratification by up to 30% when $U/NM \approx 0.5$. Large-scale internal wave motion was not evident from the observations within about 50 mesh lengths of the grid. The turbulent diffusion from a point source located 4.7 mesh lengths downstream was studied. σ_y, σ_z, the horizontal and vertical plume widths, were measured by a rake of probes. σ_y was found to be largely unaffected by the stratification and grew like $\tau^{1/2}$, while σ_z was found in all cases to reach an asymptotic limit $\sigma_z \propto$ where $0.5 < \sigma_z \propto N/w'_s < 2$, w'_s being the r.m.s. velocity fluctuations at the source; the time taken for σ_z to reach its maximum was about $2N^{-1}$. These results are largely in agreement with the theoretical models of Csanady of models (1964) and Pearson, Puttock & Hunt (1983).

AR-010

Charlson, R. J., T. Silver, A. D. Clarke, and B. A. BODHAINE. Comments on "Transport of Asian desert aerosol to the Hawaiian Islands." Journal of Applied Meteorology 21(11):1775-1776 (1982).

No abstract.

AR-011

CHING, J. K. S., J. F. CLARKE, and J. M. GODOWITCH. Modulation of heat flux by different scales of advection in an urban environment. Boundary-Layer Meteorology 25:171-191 (1983).

Sensible heat flux data obtained from the U.S. Environmental Protection Agency's Regional Air Pollution Study in St. Louis, Missouri are presented and discussed. Large spatial variations exist in heat flux on both a land-use scale and the urban scale. Arguments based upon empirical data and sampling theory show that estimates of heat flux representative of an upwind fetch l_x require a minimum observation height proportional to $z^{3/4}$. The influence of advection on the magnitude of the heat flux is also explored for both the urban and sub-urban or land-use scales. The data clearly indicate that advection can strongly modulate and even dominate the vertical heat flux above surfaces in areas which maintain large horizontal temperature gradients. The advection contribution is positive for cold air advection and negative for warm air advection, and may result from either the urban heat island or land-use mesoscale features. The depth of advective influence is directly proportional to the horizontal scale of the phenomenon and inversely proportional to horizontal temperature gradient.

AR-012

CHING, J. K. S., J. F. CLARKE, J. S. IRWIN, and J. M. GODOWITCH. Relevance of mixed layer scaling for daytime dispersion based on RAPS and other field programs. Atmospheric Environment 17:859-871 (1983).

A brief review and assessment of field measurement programs that provide data for mixed layer diffusion research is presented. The majority of programs emphasize either the meteorological aspects of the mixed layer or plume characterization. Few programs are available that provide the complimentary blend of plume and appropriate meteorological measurements needed to adequately validate mixed layer diffusion theory. Three major U.S. EPA (Environmental Protection Agency) field programs that provide databases for model development and validation of mixed layer diffusion processes are described and discussed in more detail. The Regional Air Pollution Study (RAPS) focused on measurements of surface and mixed layer turbulent transport processes in the urban environment. The Tennessee Plume Study (TPS) obtained a database with coincident measurement of boundary layer turbulent structure and plume dispersion for a large coal-fired power plant in nonuniform terrain over the diurnal cycle. The North East Regional Oxidant Study (NEROS) obtained data on transport and dispersion of regional air mass along with supporting documentation on the spatial variations of mixed layer depths, vertical turbulent transport processes, cloud fluxes, energy budget and synoptic conditions. A design feature common throughout these experimental programs, but primarily in the RAPS and TPS, was the provision to study significant land-use scale variations and processes which influence the diffusion process. Current similarity predictions of the relevant turbulent parameters are assessed in this context. Additionally, the role of convective clouds rooted within the mixed layer in pollution dispersion as a consequence of mixed layer processes is briefly described.

AR-013

CLARK, T. L., and T. R. Karl. Application of prognostic meteorological variables to forecasts of daily maximum one-hour ozone concentrations in the northeastern United States. Journal of Applied Meteorology 21:1662-1671 (1982).

A linear multiple regression equation was developed for each of 27 ozone monitoring sites in the northeastern United States to forecast the next day's maximum 1-h average ozone concentration. Thirty-five

prognostic meteorological variables, the climatological daily maximum surface temperature, the length and direction of 12- and 24-h backward trajectories, and three air quality variables relating to the seasonality or the up-wind ozone concentrations were considered as possible predictors in each of the regression equations. Data pertaining to 244 randomly selected days formed the developmental or the dependent data set, while the data pertaining to the remaining 122 days in the months of June, July, August and September of 1975, 1976 and 1977 were used to assess the performance of the regression equations. Performance was assessed and compared to that of persistence, via statistical evaluations of site-specific forecasts. In addition, areas of the Northeast where the 1-h ozone standard was predicted to be exceeded, were compared to the areas where the standard was exceeded. The results indicated that approximately half of the predictions generated from the independent data set were within 20% of the observations, while 77% were within 40% of the observations. A tendency for the underprediction of the maximum concentrations was noted. Overall, the regression equations performed best in forecasting the trends and patterns of the daily 1-h average ozone concentrations.

AR-014
  CLARKE, J. F., and J. K. S. CHING. Aircraft observations of regional transport of ozone in the northeastern United States. Atmospheric Environment 17:1703-1713 (1983).

A regional-scale aircraft sampling program was conducted during August 1979 to obtain data for validation of a regional-scale photochemical air quality simulation model and for studying the physical and chemical processes important in long-range transport of ozone and ozone precursors throughout the diurnal cycle. Three aircraft were deployed in a Lagrangian sampling mode to obtain continuous measurements of ozone, oxides of nitrogen, nephelometer scattering coefficient, and grab samples to be analyzed later for hydrocarbon species. The analysis reported herein is for a 24 hour period during which relatively high ozone concentrations, generated within urban plumes, were transported from Ohio to the Northeast Corridor.

AR-015
  Clements, W. and C. J. NAPPO. Observations of a drainage flow event on a high-altitude simple slope. Journal of Climate and Applied Meteorology 22(2):331-335 (1983).

Observations of a drainage flow event on a high-altitude simple slope were made for a few hours during a five-day field study that was otherwise characterized by high and gusty winds blowing across the face of the slope believed due to the presence of a nocturnal jet. A simple slope in the Jemez Mountains of north-central New Mexico was instrumented with meteorological surface stations and 10 m masts. Data collected during the drainage flow event indicate a depth ranging from greater than 10 m at the bottom of the slope to near zero at the top. At the bottom of the slope, the wind speed varied from 2.5 m s^{-1} at 1.5 m above ground to 0.5 m s^{-1} at a height of 10 m.

AR-016
  COULSON, K. L. Effects of El Chichon volcanic cloud in the stratosphere on the intensity of light from the sky. Applied Optics 22(15):2265-2271 (1983).

This is the second of two papers dealing with the effects of volcanic debris from the eruption of El Chichon on light from the sunlit sky. The polarization of skylight was considered in the first of the two, whereas this one is devoted to skylight intensity. It is shown here that the magnitude of the skylight intensity is modified very significantly from its clear sky value by the volcanic dust cloud, as is its change with solar degression angle during twilight and its distribution over the sky during the day. Emphasis is on measurements at a wavelength of 0.07 μm. Generally the volanic cloud produces a diminution of zenith intensity during twilight with a considerable enhancement of intensity over the sky throughout the main part of the day. The solar aureole is not as sharp as it is in normally clear conditions, but the volanic cloud causes a very diffuse type of aureole which covers a large portion of the sky. The preferential scattering of the longer wavelengths of sunlight, which is made evident by brilliant red and yellow colors in the sunrise period, causes a pronounced change of longwave/shortwave color ratios during twilight from their values in clear atmospheric conditions. The combination of intensity data shown here with polarization data in the previous paper should give a relatively complete picture of the effects of volcanic debris on solar radiation in the atmosphere and be useful in the verification of radiative transfer models of atmospheric turbidity.

AR-017
  CULKOWSKI, W. M. Digital imaging of smoke plumes. Preprints, Fifth Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Canada. American Meteorological Society, Boston, 530-531 (1983).

Smoke plume analysis through photographic techniques both in situ and in wind tunnels has been a common tool in fluid dynamics for well over three quarters of a century. By employing the failure of film speed reciprocity, Culkowski (1961), and an easily applied plume length vs width technique, Gifford (1959), the more commonly required plume parameters necessary for environmental analysis are readily calculable for any visible plume. The introduction and wide spread use of video equipment has enabled six hours of image data to be gathered at less cost than six minutes of conventional film cinematography. Analysis of even a single photograph can be tedious, subjective and expensive. To exploit the potential of video photography an objective, low cost method of analysis is essential. We selected a Digital Graphic System CBX-400 digital analyzer. This is a low cost unit (about $10 K) capable of "grabbing" a single frame from a television image and storing the gray scale image of the 242x512 "pixel" (point) raster. The digitizer will discriminate up to 256 shades of gray per pixel. Each of these gray scales may then be reproduced in one of 256 shades of red, green, blue or any combination thereof, yielding over 16 million color combinations. For visual analysis, one merely selects a threshold brightness and color everything that is brighter, or denser, a selected hue. The plume in the colored area or outlined in color is the defined objective. With practice, gray scales differing only slightly can be given very different colors, enabling isopleths to be clearly delineated.

AR-018
Davis, J. M., A. J. Riordan, and R. E. LAWSON, JR. A wind tunnel study of the flow field within and around open-top chambers used for air pollution studies. Boundary-Layer Meteorology 25:193-214 (1983).

The EPA Meterological Wind Tunnel was used to examine the flow field in and around models of open-top field-plant growth chambers used to assess the effects of pollutant gases on plant growth. Baffles designed to reduce the ingress of ambient air into the chamber through the open top were tested; the mean flow and turbulence in the simulated boundary layer with and without the chambers were compared (the chamber was operated with and without the pollutant flow system on); and the effects of surrounding chambers on the concentration field were measured. Results showed that a baffle with a reduced opening vertically above the test area maintained the highest uniform concentration in the test area. The major differences between the three (no chamber and the chamber with flow on and off) mean velocity profiles occurred below $z/h = 2.0$ (h is chamber height) and at $x/h < 4.2$. The three Reynolds stress profiles were similar above $z/h = 2.0$. Downwind of the chamber, the Reynolds stresses in the on-mode were greater than those in the off-mode above $z/h = 1.1$. The reverse was true below that point. Both longitudinal and vertical intensities above and downwind of the chamber were greater with the mixture flow system on rather than off, below about $z/h < 1.5$. Lateral variations in the mean wind indicated that the mean velocity was greater with the mixture flow system on except near the centerline where the reverse was true. The concentrations in the downwind wake resembled those for a cube. The location of a cylinder within a regular array had some effect on its internal gas concentration. Locations near the upwind and downwind edges of the array were associated with lower concentrations, although for all locations the highest internal values were always found at the lowest portion of the upwind wall. With active cylinders down-wind, the gas plume emitted from a source cylinder at the windward edge of the array was forced 0.5 h higher and the centerline meandered laterally when compared with the single-cylinder case. A cylinder located at $x/h = 1.0$ downwind from a source cylinder received approximately 3% of the concentration input to the source, or roughly 10% of the actual concentration within the source cylinder.

AR-019
DELUISI, J. J., E. G. DUTTON, K. L. COULSON, T. E. DEFOOR, and B. G. MENDONCA. On some radiative features of the El Chichon volcanic stratospheric dust cloud and a cloud of unknown origin observed at Mauna Loa. Journal of Geophysical Research 88(C11):6769-6772 (1983).

We present some results of our initial optical observations of the El Chichon volcanic cloud. These observations were made at the Geophysical Monitoring for Climatic Change Mauna Loa Observatory, Hawaii, and consist of lidar profiles, optical thickness, spectral variation in optical thickness and changes in global and direct solar broadband fluxes. Particle size distribution and cloud mass information contained in the optical thickness observations are discussed. It is clear that the atmospheric radiative effects of the El Chichon cloud far exceed the effects of all other volcanic clouds observed at Mauna Loa since observations were begun in 1958.

AR-020
DELUISI, J. J., and J. M. HARRIS. A determination of the absolute radiant energy of a Robertson-Berger meter sunburn unit. Atmospheric Environment 17(4):751-758 (1983).

Data from a Robertson-Berger (RB) sunburn meter were compared with concurrent measurements obtained with an ultraviolet double monochromator (DM), and the absolute energy of one sunburn unit measured by the RB-meter was determined. It was found that at a solar zenith angle of 30° one sunburn unit (SU) is

equivalent to 35 ± 4 mJcm^{-2}, and at a solar zenith angle of 69°, one SU is equivalent to 20 ± 2 mJcm^{-2} (relative to a wavelength of 297 nm), where the rate of change is non-linear. The deviation is due to the different response functions of the RB-meter and the DM system used to simulate the response of human skin to the incident u.v. solar spectrum. The average growth rate of the deviation with increasing solar zenith angle was found to be 1.2% per degree between solar zenith angles 30 and 50° and 2.3% per degree between solar zenith angles 50 and 70°. The deviations of response with solar zenith angle were found to be consistent with reported RB-meter characteristics.

AR-021

DELUISI, J. J., B. G. MENDONCA, E. G. DUTTON, M. A. Box, and B. M. Herman. Radiative properties of the stratospheric dust cloud from the May 18, 1980, eruption of Mount St. Helens. Journal of Geophysical Research 88(C9):5290-5298 (1983).

Measurements of the 2π-sr (hemispheric) diffuse-sky, direct, and total (diffuse and direct) transmitted solar flux were made at Boulder, Colorado, during the passage of the Mount St. Helens dust cloud on May 19 and June 3, 1980. The measurements were both narrow-band and broadband integrated over the solar spectrum. Verification of the presence of the cloud and its vertical profile was obtained by lidar. Analysis of the flux measurements by a perturbation technique yielded volcanic cloud optical properties useful for studies of climate variation. The ratio of backscatter to total scatter, imaginary term of the complex refractive index, albedo of single scatter, and optical depth are determined from the measurements. Estimates of solar radiation absorption and backward and forward scattering by the cloud are given. Certain radiative characteristics of the Agung volcanic cloud and the Mount St. Helens volcanic cloud are compared.

AR-022

DONNELLY, R.F. Solar UV spectral irradiance variations. Weather and Climate Responses to Solar Variations. Colorado Associated University Press (1983).

Solar variations in the UV spectral irradiance are discussed with emphasis on the wavelengths important for producing or destroying ozone and heating the stratosphere. Short-term variations of days and weeks have now been well observed by the NIMBUS-7 and SME satellites. The size of the short-term variations at wavelengths longer than 160 nm are smaller than the 7% annual variation in incident flux produced by the orbital variations in the Sun-Earth distance. The percentage short-term variations are about twice as strong at the ozone production wavelengths as at the ozone destruction and stratospheric heating wavelengths. The short-term temporal variations are not simple sinusoids of the 27 day solar-rotation rate but include a much larger range of periods and also shifts in phase according to the location and apparent motion of active regions on the sun. Intermediate-term UV variations lasting a few months, associated with major rounds of solar activity, are discussed. They may account for some of the missing energy blocked by sunspots. The very important long-term and solar-cycle variations are the most poorly observed because of problems in satellite instrument degradation in space and difficulties in intercomparing measurements from different experiments. Long-term results are reviewed with emphasis on their limitations and speculation on long-term trends other than the 11 year sunspot cycle. Progress in modeling the solar UV flux temporal variations based on solar spatial data is reviewed with emphasis on the role of modeling in intercomparing isolated measurements and for providing better UV estimates for past times than indices like the 10.7 cm solar radio flux or sunspot number can provide.

AR-023

DONNELLY, R. F., D. F. Heath, and J. L. LEAN. Active-region evolution and solar rotation variations in solar UV irradiance, total solar irradiance, and soft X rays. Journal of Geophysical Research 87(A12): 10318-10324 (1982).

Variations in the solar UV spectral irradiance, the total solar irradiance, and solar soft X ray emission over days and weeks are analyzed by using concurrent measurements from the NIMBUS7 and GOES satellites. The UV variations at wavelengths (160-400 nm) of interest to ozone photochemistry and the physics of the middle atmosphere are emphasized. The nonflare variations studied are caused by two types of processes: (1) the birth, growth, peak, and decay of solar active regions and (2) solar rotation, for example, when portions of active regions are occulted near the solar limb. The observations are interpreted by using simple empirical models that relate ground-based observations of the size and location of sunspots and plages to the full-disk temporal variations. The major dips observed in the total solar irradiance on August 20-23 and November 6-10, 1979, and April 8, May 25, and September 1, 1980, are accompanied by only average UV and X ray enhancements. The models show that the active regions associated with the sunspots responsible for the major dips in the total solar irradiance caused strong but not outstanding emission enhancements at UV and X ray wavelengths. The solar rotation variations are studied as a function of the central meridian distance of solar active regions where the central meridian distance

width at half the maximum is narrowest for decreases in the total solar irradiance (~ 83 degree), slightly wider and also a function of wavelength for UV enhancements (~ 95 degree at 198 nm), wider still for the 10.7 cm radio flux (~ 150 degree), and extremely wide for soft X rays ($\geq$ 205 degree).

AR-024
DONNELLY, R. F., D. F. Heath, J. L. LEAN, and G. J. Rottman. Temporal variations of solar UV irradiance caused by solar rotation and active region evolution. Proceedings of the Workshop on Solar Irradiance Variations on Active Region Time Scales, June 20-21, Pasadena, California. NASA Conference Publication, Pasadena (1983).

Variations in the solar 100-400 nm UV spectral irradiance caused by solar rotation and active region evolution, are discussed as a function of UV wavelength, CMD dependence, and in relation to the temporal variations in the total solar irradiance, 10.7 cm radio flux, sunspot number and Ca K plage data. Active region radiation at cm wavelengths includes a component proportional to the magnetic field. Active region evolution involves a more rapid growth, peak and decay of sunspots and their strong magnetic fields than the Ca K plages and their related UV enhancements. Major plages often last a rotation or more longer than the active region's sunspots. Large active regions, including those associated with major dips in the total solar irradiance, tend to produce the strongest peaks in 10.7 cm and sunspot numbers on their first rotation, while the Ca K plages and UV enhancements peak on the next rotation and decay more slowly on subsequent rotations. Differences in CMD dependencies cause temporal differences including the stronger presence of 13-day variations in the UV flux.

AR-025
DRAXLER, R. R. Model validation using Krypton-85 air concentration data from the 1500 km long-range dispersion experiment. Sixth Symposium on Turbulence and Diffusion, March 22-25, 1983. American Meteorological Society, Boston, 139-141 (1983).

No abstract.

AR-026
DRAXLER, R. R. Variability in winds and temperatures from sequential rawinsonde ascents. Reprinted from Preprint Volume: Fifth Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Ont., Canada. American Meteorological Society, Boston, 258-260 (1983).

No abstract.

AR-027
DRAXLER, R. R. Measuring and modeling the transport and dispersion of Krypton-85 1500 km from a point source. Atmospheric Environment 16(12):2763-2776 (1982).

The 1974 long-range dispersion experiment in which Kr-85 was released from the Idaho National Engineering Laboratory and sampled twice-daily at 13 locations in the midewestern U.S. was considered inconclusive because very few distinct plumes were observed during the two month experimental period. These data have been reanalyzed and compared with model-calculated concentrations after filtering unde- sired noise by using the coherence of the measured and calculated air concentration time series as a weighting function. The dispersion model, which is responsive to the effects of wind shear, performed exceptionally well at the more southern samplers in Oklahoma and Kansas. At the northern sites the Kr-85 from Idaho was masked by fluctuations in background concentration as well as small local sources, both of which produced concentration fluctuations of similar magnitude to the Idaho source. Further, the transport of Kr-85 from Idaho to the northern samplers involved more complicated meteorological regimes than could be accounted for by a simple Lagrangian transport model.

AR-028
ELLIOTT, W. P. A note on the historical industrial production of carbon dioxide. Climatic Change 5: 141-144 (1983).

The historical record of CO_2 emissions from industrial activity is reexamined. The overall annual growth rate has been about 3.5% but with wide variations due to economic fluctuations. It is unlikely that the total CO_2 production would have been greatly different had the major wars of the Twentieth Century been avoided.

AR-029
  ESKRIDGE, R. E., and R. S. Thompson. Experimental and theoretical study of the wake of a block-shaped
  vehicle in a shear-free boundary flow. Atmospheric Environment 16:2821-2836 (1982).

  The wake of a moving vehicle was simulated using a specially-constructed wind tunnel with a moving
floor. A "block-shaped" model vehicle was fixed in position over the test-section floor while the floor
moved at the freestream air speed to produce a uniform, shear-free, approach flow. This simulates an
automobile traveling along a straight highway under calm atmospheric conditions. Vertical and lateral
profiles of mean and fluctuating velocities and Reynolds stresses in the wake of the vehicle were
obtained using a hot-film anemometer with an X-probe. Profiles were taken at distances of 10-80 model
heights downwind. A momentum type wake was observed behind the block-shaped vehicle. The wake does not
have a simple self-preserving form. However, it is possible to collapse the velocity deficit with one
length and one velocity scale. Two new theories for the velocity deficit are compared to the theory of
Eskridge and Hunt (1979). A theory which considered a height-dependent eddy viscosity was found to fit
the data best. Length and velocity scales were found for the longitudinal variation of the turbulent
kinetic energy. The lateral variation is described by a two-dimensional numerical fit of the crosswind
variation of the data.

AR-030
  Evans, G., P. L. FINKELSTEIN, B. Martin, N. C. POSSIEL, and M. Graves. Ozone measurements from a net-
  work of remote sites. Journal of the Air Pollution Control Association 33:291-296 (1983).

  The EPA, in cooperaton with the U.S. Forest Service, has established a network of air monitoring sta-
tions designed to measure levels of ozone in remote areas within the contiguous 48 states. There are
currently 8 sites, at various National Forests, which measure ozone, wind speed and direction, tem-
perature, relative humidity, and solar radiation. This is a review of the network data collected during
1979, the year for which the most complete meteorological and ozone records were available. The mean
ozone level for 1979 at these sites fell within the range of 0.025-0.04 ppm. At most sites, there were
several days in 1979 when hourly concentrations of ozone exceeded 0.08 ppm. The maximum 1 h ozone con-
centration observed was 0.125 ppm. The report provides analyses of the statistical distributions of the
ozone data from these remote sites, their relationships with local meteorological data, and the possible
impact of air parcel history upon ozone concentration. Examination of several individual days in 1979
with relatively high ozone levels using a back trajectory model showed that in almost all of these cases,
the air had passed over large urban areas within the previous 3 days. The hypothesis is presented that
high levels of ozone at remote sites may be due in part to the long range transport of ozone and/or its
precursors.

AR-031
  Flythe, M. C. and B. B. Amlicke. Catalog of the existing Short Range Experiment (SRE) data base
  (Addendum to NOAA Technical Memorandum ERL ARL-80). NOAA-TM-ERL-ARL-119 (PB83-204347), 46 pp. (1983).

  No abstract.

AR-032
  Galloway, J. N., G. E. Likens, W. C. Keene, and J. M. MILLER. The composition of precipitation in
  remote areas of the world. Journal of Geophysical Research 87(11):8771-8786 (1982).

  The Global Precipitation Chemistry Project collects precipitation by event to determine composition and
processes controlling it in five remote areas. Compositions (excluding seasalt) at St. Georges, Bermuda,
were primarily controlled by anthropogenic processes; compositions and acidities at San Carlos, Venezuela,
Katherine, Australia, Poker Flat, Alaska, and Amsterdam Island were controlled by unknown mixtures of
natural or anthropogenic processes. Precipitation was acidic; average volume-weighted pH values were 4.8
for Bermuda; 5.0, Alaska; 4.9, Amsterdam Island; 4.8 Australia; 4.8, Venezuela. Acidities at Bermuda and
Alaska were from long-range transport of sulfate aerosol; at Venezuela, Australia, and Amsterdam Island,
from mixtures of weak organic and strong mineral acids, primarily H_2SO_4. Relative proportions of weak to
strong acids were largest at Venezuela and lowest at Amsterdam Island. Weak and strong acids were from
mixtures of natural and anthropogenic processes. Once contributions from human activities were removed,
the lower limit of natural contributions was probably $\geq$pH 5.

AR-033
  GAMMON, R. H., J. CLINE, and D. WISEGARVER. Chlorofluoromethanes in the Northeast Pacific Ocean:
  Measured vertical distributions and application as transient tracers of upper ocean mixing. Journal of
  Geophysical Research 87(C12):9441-9454 (1982).

The vertical distributions of the man-made chlorofluoromethanes CCl_3F (F-11) and CCl_2F_2 (F-12) have been measured at two locations in the eastern North Pacific Ocean to depths greater than 500 m. At both sites (46°N, 125°W off the Washington-Oregon coast and 50°N, 140°W in the Gulf of Alaska) the halomethane concentrations were found to fall off exponentially with increasing depth below the mixed layer. For F-11 at 50°N, the surface concentration (3.2×10^{-12} mol/l) was found to be in saturation equilibrium with the measured atmospheric concentration (190 pptv). The measured cholorfluoromethane profiles have been interpreted in terms of a one-dimensional model for the vertical diffusion/advection of an exponentially driven, conservative tracer into a bottomless ocean. In the appropriate limit of 'transient steady state' the projected profiles are simple exponentials described by an advective-diffuse scale depth H, which is a function of the vertical eddy diffusivity K_z, the upwelling velocity w, and the characteristic time τ for the exponential growth of the tracer concentration at the boundary. At the two ocean locations studied the freon thermocline depth scales were in the range $H \simeq 120-140$ m, with F-12 generally 10-20% deeper than F-11. At 50°N the F-11 and F-12 vertical profiles gave consistent values of vertical diffusivity ($K_z \sim 1.2-1.3$ cm^2s^{-1}) and upwelling velocity ($w \simeq 12-14$ m yr^{-1}). The model also allows a simple scaling from one exponentially driven, transient tracer (freon) to another (fossil fuel CO_2), leading to a predicted mean depth of penetration of fossil fuel CO_2 of approximately 300 m in the eastern North Pacific.

AR-034
  GILLETTE, D. A. Decomposition of annual patterns of atmospheric carbon dioxide concentrations: A preliminary of one year of data at 13 globally distributed locations. Atmospheric Environment 16(11): 2537-2542 (1982).

The fluctuations of monthly mean CO_2 concentrations for 14 globally distributed locations for 1979 were decomposed into three independent patterns. The first pattern seemed to suggest a globally averaged pattern caused primarily by fluxes into and from the biosphere. The second pattern suggested an oceanic effect that changes the phase of the annual CO_2 fluctuation. The third pattern suggested a biospheric effect that deepens the minimum CO_2 concentrations in northern latitudes.

AR-035
  GILLETTE, D. A. Future research in resuspension. In Precipitation Scavenging, Dry Deposition, and Resuspension, Vol. 2, Pruppacher et al. (eds.), Elsevier, New York, 1443-1445 (1983).

No abstract.

AR-036
  GILLETTE, D. A. The concept of resuspension rates applied to problems of fugitive dust emissions and wind erosions. In Precipitation Scavenging, Dry Deposition, and Resuspension, Vol. 2, Pruppacher et al. (eds.), Elsevier, New York, 1059-1072 (1983).

No abstract.

AR-037
  GILLETTE, D. A. Threshold velocities for wind erosion on natural terrestrial arid surfaces (A summary). In Precipitation Scavenging, Dry Deposition, and Resuspension, Vol. 2, Pruppacher et al. (eds.), Elsevier, New York, 1047-1057 (1983).

No abstract.

AR-038
  GILLETTE, D. A., J. Adams, D. Muhs, and R. Kihl. Threshold friction velocities and rupture moduli for crusted desert soils for the input of soil particles into the air. Journal of Geophysical Research 87(C11):9003-9015 (1982).

Desert soils having clay crusts, mostly from the Mojave Desert, were tested for threshold friction velocity (the friction velocity at which soil erosion begins) with an open-bottomed wind tunnel. The soils were also tested for content of clay, water-soluble material, calcium carbonate, organic material, mineralogy of clay and of salts, soil moisture, modulus of rupture, and crust thickness. If no loose material existed on the soil surface, crusts having modulus of rupture greater than 0.7 bar and crust thickness of 0.7 cm to 0.3 cm were effective in protecting against wind erosion. Disturbed clay crusts having modulus of rupture before disturbance greater than 2 bar with thickness less than 1.9 cm did not experience significant wind erosion. Modulus of rupture was related to composition of soil but was shown to depend mostly on clay content. Soil composition is related to modulus of rupture in an empirical equation.

AR-039
  GILLETTE, D. A., and K. J. HANSON. Sampling strategy to obtain data used in models of global annual CO_2 increase and global carbon cycle. Journal of Geophysical Research 88(C2):1345-1348 (1983).

  Simple models were constructed to assess with somewhat limited CO_2 data the effects of both frequency of sampling and spatial distribution of sampling locations on the variance of estimates of interest to the global carbon cycle. The CO_2 data for use in these models were obtained from seven air flask sampling locations, globally distributed in latitude but restricted to the longitude sector 80°W to 170°W, during the period 1977-1979. The results of analysis with these models show (1) that locations north of 30°N are quite important in possibly providing information on carbon cycle exchange processes and that (2) improved sampling techniques including greater sampling frequency would be desirable for sampling locations in the southern hemisphere.

AR-040
  GILLETTE, D. A., and A. T. Steele. Selection of CO_2 concentration data from whole-air sampling at three locations between 1968 and 1974. Journal of Geophysical Research 88(C2):1349-1359 (1983).

  Three methods for rejection of CO_2 data were used to obtain CO_2 concentration versus time for 1968-1973 for Station Charlie (a ship in the North Atlantic), Niwot Ridge near Nederland, Colorado, and Key Biscayne near Miami, Florida. From examination of the results it was concluded that short-term variation and error were not large for the Station Charlie data. There was a suggestion of occasional contamination at Key Biscayne and evidence of more frequent contamination at Niwot Ridge, after 1970. Values obtained for annual CO_2 increases were 1.3 and 1.2 ppm (1959 SIO index) for Station Charlie and Niwot Ridge. Annual amplitudes were 15, 11, and 9.7 ppm for Station Charlie, Niwot Ridge, and Key Biscayne, respectively.

AR-041
  HANSON, K., and G. COTTON. Temperature variation in the United States during June: A search for causes and mechanisms. Solar-Terrestrial Influences on Weather and Climate. Second International Symposium, August 2-6, 1982, Boulder, Colo. University of Colorado Press (1983).

  The periodic behavior of temperature variability in the United States is considered. Greatest non-seasonal 11-yr variability occurs during June in the upper midwest and western Great Lakes states. This temperature variability is associated with, and may be caused by, mid-tropospheric "blocking" in the northeast Gulf of Alaska, eastern Alaska, and northwest Canada. The cause of this blocking is unknown. A pressure "seesaw" between centers in the southeastern United States and in the northern plains is the mechanism for the observed temperature variability. An explanation is suggested for the nonstationarity of the observed temperature variability. Four statistical tests are used to examine the association of this temperature variability with both sunspot number and year of the sunspot cycle.

AR-042
  HARRIS, J. M. The GMCC atmospheric trajectory program. NOAA-TM-ERL-ARL-116 (PB83-146647), 30 pp. (1983).

  No abstract.

AR-043
  Hay, J.E., and K.J. HANSON. Evaluating the solar resource: Problems resulting from temporal, spatial and angular variations. Progress in Solar Energy, American Solar Energy Society (1983).

  Accurate assessment of the availability of solar energy at the Earth's surface is hampered by difficulties associated with the variability of solar radiation in space and time and with the angular position in the sky hemisphere. This paper assesses each of these problem areas by highlighting the difficulties and the attempts to offset them. Major emphasis is placed on extrapolation and interpolation procedures, the sensitivity of inclined surfaces to variations in the solar input, numerical models for calculating the irradiance of inclined surfaces and the time scales for which these computations are valid. Finally, the reader is urged to consider the significance of these difficulties in light of both radiation measurement errors and the sensitivity of the application to imprecise determinations of the radiation environment.

AR-044

Heath, D.F., R.F. DONNELLY, and R.G. MERRILL. NIMBUS-7 SBUV observations of solar UV spectral irradiance variations caused by solar rotation and active region evolution for the period November 7, 1978-October 26, 1979. NOAA-TR-ERL-427-ARL-7, 45 pp. (1983).

Observations of temporal variations of the solar UV spectral irradiance over several days to a few weeks in the 160-400 nm wavelength range are presented in detail. The measurements were made by the Solar Backscatter Ultraviolet experiment on the NIMBUS-7 satellite during the period November 7, 1978, to October 26, 1979. The spectra of the variations in solar UV radiation caused by active region evolution and solar rotation are presented for the 15 largest variations. To a first-order approximation, these-15 cases have essentially the same spectral shape and a small range in intensity. At wavelengths shorter than about 208 nm, the aluminum continuum enhancement dominates the spectra; at longer wavelengths, the magnesium continuum and lines dominate. The average spectrum for the 15 cases is interpreted as being the spectrum for variations caused by solar rotation. Second-order effects, probably caused by active region evolution, are discussed. Autocorrelation analysis of the data indicates a peak at periods or lags of about 27 days where the peak may broaden toward lags of about 25 days at wavelengths longer than the aluminum edge, i.e., in the 208-300 nm range.

AR-045

HEFFTER, J. L., Branching Atmospheric Trajectory (BAT) model. NOAA-TM-ERL-ARL-121 (PB83-233023), 16 pp. (1983).

A Branching Atmospheric Trajectory (BAT) model that can be used for a variety of long-range diagnostic and assessment purposes is presented. The three-level Lagrangian model can calculate trajectories forward or backward in time that branch due to vertical wind shears associated with day/night transitions. Model output includes tabulated concentrations at one or more sampling sites, concentration maps, and trajectory maps depicting a branched trajectory with the mass at each day/night transition and layer identification for each branch.

AR-046

HICKS, B. B. Monitoring: Dry deposition. The Acidic Deposition Phenomena and its Effects: Critical Assessment Review Papers, Vol. I, EPA-600/8-83-016A, Office of Research and Development, Washington, D.C., 8-11 to 8-23 (1983).

Various approaches to the subject of dry deposition monitoring are discussed, including the use of collective vessels, surrogate surfaces, and micrometeorological methods. At this time there is no method suitable for routinely monitoring dry deposition rates of trace gases and small aerosol particles, hence it is preferred to evaluate deposition from measurements of pollutant concentration in air and supporting meteorological, biological, and chemical data. To accomplish this, it is necessary to understand how appropriate deposition velocities vary with time, space, and with the nature of the species and the underlying surface. Present information on average dry deposition rates is very limited; however, it is known that dry deposition is more of a source-oriented phenomenon than wet. Most workers agree that dry deposition is of similar importance to wet, on the average, although this cannot be expected to be the case at all locations or in all situations.

AR-047

HICKS, B. B. Wet and dry surface deposition of air pollutants and their modeling. In Conservation of Historic Stone Buildings and Monuments, National Academy Press, Washington, D.C., 183-196 (1982).

Both wet and dry deposition of pollutants can cause significant deterioration of exposed stonework. Wet deposition imposes sudden but infrequent doses of pollutants, most of which will be in dilute solution. Concentrations will vary widely both in time and in space, but as a rule of thumb the pH will be roughly normally distributed, with a standard deviation of about 1.0. It is obviously possible to protect exposed surfaces from the direct effect of precipitation, but it is not immediately clear that the use of shelters will generally be beneficial. Dry deposition is a slower but more continuous process than wet deposition, and it is always possible that incident precipitation will wash off material previously deposited by dry processes. In cold weather the mechanical effects associated with repeated freezing and thawing of water are likely to overwhelm all other factors. Both dry and wet fluxes will be greatest when air concentrations of pollutants are high. Although the relationship between air concentrations and the chemical composition of precipitation is exceedingly complicated, rates of deposition by dry mechanisms are intimately related to air quality in the immediate vicinity of receptor surfaces. However, the present state of knowledge regarding pollutant uptake by surfaces of any kind is rather rudimentary. Nevertheless, important processes can be identified with some confidence. While the rates of uptake cannot

be predicted at all closely, the circumstances under which the greatest fluxes occur can be determined. Some surface properties that are likely to cause locally enhanced deposition can be identified, and hence areas that are potentially at risk can be singled out.

AR-048

HICKS, B. B., M. L. Wesely, R. L. Coulter, R. L. Hart, J. L. Durham, R. Speer, and D. H. Stedman. An experimental study of sulfur deposition to grassland. Proceedings, Precipitation Scavenging, Dry Deposition and Resuspension, Volume 2, November 29-December 3, 1982, Santa Monica, California. Elsevier Science Publishing Co., Inc., New York, 933-942 (1983).

Three independent flame photometric sulfur sensors were used in an investigation of the eddy flux of atmospheric sulfur compounds to natural grassland, conducted in southern Ohio during September 1979. One of the detectors was operated with a filter to remove particles from the air stream being sampled. Another was operated with a denuder tube, to remove sulfur dioxide. The third detector was operated with no modification of the sampling system, so that total sulfur concentration was measured. For gaseous sulfur, a residual surface resistance (i.e., the total resistance to transfer after allowance is made for the aerodynamic component) of about 1.0 s/cm was measured for daytime, unstable conditions. For particulate sulfur, a value of about 2.5 s/cm was obtained, so that particulate sulfur deposited more slowly than gaseous. The third sensor provided some confirmation of this conclusion. When combined with aerodynamic resistances that are typical of the diurnal cycle over grassland, average deposition velocities are found to range between nocturnal low values of about 0.2 cm/s for SO_2 (0.1 cm/s for SO_4) and daytime high values of about 0.8 cm/s for SO_2 (0.4 cm/s for SO_4). Long-term averages of about 0.4 cm/s for SO_2 and 0.2 cm/s for SO_4 seem appropriate for modeling deposition to unimproved grassland.

AR-049

HUBER, A. H., and W. H. SNYDER. Wind tunnel investigation of the effects of a rectangular-shaped building dispersion of effluents from short adjacent stacks. Atmospheric Environment 16:2837-2848 (1982).

In a wind tunnel study, the influence of the highly turbulent region found in the lee of a model building upon plumes emitted from short stacks was examined through smoke visualization and tracer gas concentration mappings. A thick, simulated atmospheric boundary layer was used to provide background dispersion. A rectangular-shaped building with its length equal to twice its height and width was oriented with the long side perpendicular to the approaching wind. The stack was placed midway along the lee side of the building. In all phases of the study, each smoke or tracer release from the stack was repeated with the building removed. This allowed for a simple demonstration of the building wake effects. A simple mathematical model was developed that provided good estimates of concentrations in the wake of the building wake. The building influence was found to be reduced with increases in the effective source height. Application of the "2.5 times rule", i.e., an effective source height at 2.5 times the height of the building, resulted in maximum ground-level concentration in the wake being approximately 20 percent higher than found in the absence of the building. A stack 1.5 times the height of the building resulted in maximum ground-level concentrations in the wake being 250 percent higher, a far more significant effect.

AR-050

HUTCHISON, B. A. Energy conservation mechanisms and potentials of landscaping to ameliorate building microclimates. Landscape Journal 2(1):19-39 (1983).

An assessment of the space-conditioning energy conservation potentials of landscapes designed to ameliorate building microclimates is made. The physical bases for vegetative modifications of climate are discussed, and results of past study of the effects of vegetation on space-conditioning energy consumption in buildings are reviewed. The state-of-the-art of energy-conserving landscape designs is assessed and recommendations for further research presented.

AR-051

IRWIN, J. S. Estimating plume dispersion -- A comparison of several sigma schemes. Journal of Climate and Applied Meteorology 22:92-114 (1983).

The lateral and vertical Gaussian plume dispersion parameters are estimated and compared with field tracer data collected at 11 sites. The dispersion parameter schemes used in this analysis include Cramer's scheme, suggested for tall stack dispersion estimates, Draxler's scheme, suggested for elevated and releases, Pasquill's scheme, suggested for interim use in dispersion estimates, and the Pasquill-Gifford scheme using Turner's technique for assigning stability categories. The schemes

suggested by Cramer, Draxler and Pasquill estimate the dispersion parameters using onsite measurements of the vertical and lateral wind-velocity variances at the effective release height. The performances of these schemes in estimating the dispersion parameters are compared with that of the Pasquill-Gifford scheme, using the Prairie Grass and Karlsruhe data. For these two experiments, the estimates of the dispersion parameters using Draxler's scheme correlate better with the measurements than did estimates using the Pasquill-Gifford scheme. Comparison of the dispersion parameter estimates with the measurements suggests that Draxler's scheme for characterizing the dispersion results in the smallest mean fractional error in the estimated dispersion parameters and the smallest variance of the fractional errors. Centerline values of surface concentration are estimated using the Gaussian plume model and compared with the concentration values determined during five field experiments -- three for near-surface releases and two for elevated releases. Comparison of the concentration estimates with the measurements from the five field experiments suggests Draxler's scheme for characterizing the dispersion results in the smallest mean fractional error in the concentration estimates and the smallest variance of the fractional errors. Two alternative characterizations of the dispersion, formed by altering Draxler's scheme to be independent of release height, are shown to perform almost as well as Draxler's scheme.

AR-052
 IRWIN, J. S. Preparing meteorological data for use in routine dispersion calculations -- Workgroup summary report. NOAA-TM-ERL-ARL-122, 20 pp. (1983).

The conclusions of a discussion workgroup are presented outlining methods for preparing meteorological data for routine use in air quality simulation of dispersion. The goal of the workgroup was to initially accommodate Gaussian plume modeling techniques, and to expand the meteorological variable list, as needed in the future, to accommodate other dispersion estimation techniques. Methods are suggested for estimating the vertical profiles of wind velocity, temperature, and the variances of the vertical and lateral wind speed fluctuations. Procedures are suggested for estimating the mixing height and the surface layer scaling parameters, including the Monin-Obukhov stability length. Coupled with near-surface measurements from a fully instrumented low-level meteorological tower, the winds, turbulence intensities, and temperatures are estimated using empirical formulations of the vertical profiles of these variables, defined in terms of mixing height and stability. The simplistic set of methods outlined offers specific ideas and suggestions to focus future deliberations on the critical concepts which need to be examined and evaluated.

AR-053
 IRWIN, J. S. and D. B. TURNER. An analysis of Complex I and Complex II -- Candidate screening models. EPA-600/3-83-034 (PB83-207399), Environmental Science Research Laboratory, Research Triangle Park, N.C., 57 pp. (1983).

This study investigated whether or not a sequential air quality simulation model capable of accepting onsite hourly meteorological data could serve as a valid screening model for estimating worst-case pollutant impacts on complex terrain. The study intercompared the highest 24-h average pollutant concentrations predicted by four algorithmic air quality simulation models: Complex I, Complex II, Valley, and Valley-BID. Complex I and Complex II are sequential (hourly) air quality simulation models that differ only in characterization of lateral dispersion. Complex I simulates lateral dispersion by assuming a uniform distribution of pollutant spread over a 22.5 degree sector central on the input hourly wind direction. Complex II simulates lateral dispersion by assuming a Gaussian distribution as specified by the input Pasquill stability category and the downstream distance. Valley is the standard EPA screening model used for estimating worstcase 24-h concentrations. Valley-BID is Valley modified to incorporate characterization of induced dispersion arising from buoyant plume rise. The four models were applied to as year's meteorological data for two different sites. Various combinations of source release height and terrain configuration were examined. The results were compared. The authors conclude that Valley-Bid (or pencil and paper calculations using the same assumptions) is most appropriate for screening analyses designed to estimate maximum 24-h concentrations resulting from plume impaction on terrain near the height of an elevated stabilized plume.

AR-054
 KOMHYR, W. D. An aerosol and gas sampling apparatus for remote observatory use. Journal of Geophysical Research 88(C6):3913-3918 (1983).

An air sampling apparatus is described which standardizes sampling height at a field station at 10 m or more above ground level and which minimizes loss of particles and destruction and contamination of sampled trace atmospheric gases as air is conducted through the apparatus to various monitoring instruments. Basic design features render the apparatus useful for air sampling under widely varying climate conditions, and at station altitudes ranging from sea level to more than 4 km. Four systems have been built,

and have been used successfully since 1977 at the NOAA Geophysical Monitoring for Climatic Change program baseline stations at Point Barrow, Alaska; Mauna Loa, Hawaii; American Samoa, South Pacific; and South Pole, Antarctica.

AR-055
KOMHYR, W. D., L. S. WATERMAN, and W. R. Taylor. Semiautomatic nondispersive infrared analyzer apparatus for CO_2 air sample analyses. Journal of Geophysical Research 88(C2):1315-1322 (1983).

A semiautomatic nondispersive infrared analyzer apparatus has been developed for analysis of up to 50 CO_2 air samples per day. The samples are collected in 500-ml glass flasks and are transferred to the analyzer with a novel, free-floating piston pump. Sample and calibration gas transfer operations are controlled by a microprocessor, and data are recorded, analyzed, and output by a Hewlett-Packard 9845A/S desktop computer. The apparatus is described, including operating and test modes, and performance characteristics determined from 2 years of operation are given.

AR-056
KORSHOVER, J. and J.K. ANGELL. A review of air-stagnation cases in the eastern United States during 1981 - Annual summary. Monthly Weather Review 110(10):1515-1518 (1982).

The number and location of stagnation days within the eastern United States, as estimated mainly from a surface geostrophic-wind criterion, is presented by month and for the year 1981 as a whole. In 1981, the number of stagnation days exceeded the 40-year average everywhere except Florida, with a maximum frequency of occurrence somewhat to the west and north of the usual location. There were unique occurrences of stagnation in a belt extending from Minnesota to Maine, including extreme southeastern Canada.

AR-057
LAMB, R. G. A regional scale (1000 km) model of photochemical air pollution. Part I. Theoretical formulation. EPA-600/3-83-035, Environmental Sciences Research Laboratory, Research Triangle Park, N.C., 225 pp. (1983).

A theoretical framework for a multiday, 1000-km scale simulation model of photochemical oxidant is developed. It is structured in a highly modular form so that eventually the model can be applied through straightforward modifications to simulations of particulates, visibility and acid rain. The model structure is based on phenomenological concepts and consists of three and one-half layers. The interface surfaces separating the layers are functions of both space and time that respond to variations in the meteorological phenomena that each layer is intended to treat. Among the physical and chemical processes affecting passage and distribution of photochemical concentrations that the model is designed to handle are: horizontal transport, photochemistry, nighttime wind shear and the nocturnal jet; cumulus cloud effects; mesoscale vertical motion; mesoscale eddy effects; terrain effects; subgrid scale chemistry processes; natural sources of hydrocarbons, NO_x, and stratospheric ozone; and wet and dry removal processes, e.g., washout and deposition. The predictability of pollutant concentrations at long range is considered, along with such related problems as the parameterization of "mesoscale" diffusion and the design of model "validation" experiments. A basis is established for estimating quantitatively the levels of uncertainty associated with dispersion model predictions. This report focuses on theoretical aspects of the model and the question of predictability. Results of the model's performance and quantitative assessments of its predictability will be presented in subsequent parts of this report.

AR-058
LAWSON, R. E., Jr., and R. E. Britter. A note on the measurement of transverse velocity fluctuations with heated cylindrical sensors at small mean velocities. Journal of Physics E: Scientific Instruments 16:563-567 (1983).

The measurement of transverse velocity fluctuations and Reynolds stresses with heated cylindrical sensors is studied at low mean velocities, 0.5 m s^{-1}<U<10 m s^{-1}, using a dynamic technique. It is concluded that the yaw sensitivity has a significant dependence upon the mean velocity within this range.

AR-059
LAWSON, R. E., Jr., and W. H. SNYDER. Determination of good-engineering-practice stack height: A fluid model demonstration study for a power plant. EPA-600/3-83-024, Environmental Sciences Research Lab., Research Triangle Park, N.C., 70 pp. (1983).

A study using fluid modeling to determine good-engineering-practice (GEP) stack height for a power plant installation is discussed. Measurements are presented to describe the simulated boundary layer structure, plume-dispersion characteristics in the absence of the model plant building, and the maximum ground-level concentration of effluent downstream of the source, both with and without the model plant building. Analysis of the maximum ground-level concentrations shows that, in this case, a stack height of 64.1 m meets the current GEP criteria for 100% plant-load conditions.

AR-060

LEAN, J.L. UV rocket spectroscopy measurement of the nighttime ozone distribution. Journal of Geophysical Research 88(C2):1468-1474 (1983).

Nocturnal ozone densities between 32 and 72 km have been derived from observations of the full moon, made by three optical ozone detectors, each comprising three ultraviolet photometers. The three similar detectors were carried on a single spinning rocket, launched at Wallops Island on November 4, 1979. The mean of the three measured ozone profiles is consistent with other nighttime ozone profiles obtained from the LRIR satellite experiment and also from ground based millimeter wave observations. The relative standard error in the mean ozone profile is approximately 5%. At 70 km the ozone concentration of 1.5 x 10^9 cm^{-3} is a factor of three greater than the U.S. Standard Atmosphere, 1976 mid latitude daytime model.

AR-061

LEAN, J.L., and A. Skumanich. Variability of the Lyman alpha flux with solar activity. Journal of Geophysical Research 88(A7):5751-5759 (1983).

A three-component model of the solar chromosphere, developed from ground based observations of the Ca II K chromospheric emission, is used to calculate the variability of the Lyman alpha flux between 1969 and 1980. The Lyman alpha flux at solar minimum is required in the model and is taken as 2.32 x 10^{11} photons/cm^2/s. This value occurred during 1975 as well as 1976 near the commencement of solar cycle 21. The model predicts that the Lyman alpha flux increases to as much as 5 x 10^{11} photons/cm^2/x at the maximum of the solar cycle. The ratio of the average fluxes for December 1979 (cycle maximum) and July 1976 (cycle minimum) is 1.9. During solar maximum the 27-day solar rotation is shown to cause the Lyman alpha flux varies over intermediate time periods of 2 to 3 years, as well as over the 11-year sunspot cycle. We conclude that, unlike the sunspot number and the 10.7-cm radio flux, the Lyman alpha flux had a variability that was approximately the same during each of the past three-cycles. Lyman alpha calculated by the model are consistent with measurements of the Lyman alpha flux made by 11 of a total of 14 rocket experiments conducted during the period 1969-1980. The model explains satisfactorily the absolute magnitude, long-term trends, and the cycle variability seen in the Lyman alpha irradiances by the OSO 5 satellite experiment. The 27-day variability observed by the AE-E satellite experiment is well reproduced. However, the magnitude of the AE-E Lyman alpha irradiances are higher than the model calculations by between 40% and 80%. We suggest that the assumed calibration of the AE-E irradiances is in error.

AR-062

LEAN, J.L, O.R. White, W.C. Livingston, D.F. Heath, R.F. DONNELLY, and A. Skumanich. A three-component model of the variability of the solar ultraviolet flux: 145-200 nm. Journal of Geophysical Research 87(A12):10307-10317 (1982).

A three-component model has been developed to examine the variation with solar activity of the far ultraviolet irradiance between 145 and 200 nm. This model is based on spatially resolved observations of the Ca II K chromosphere and includes the contributions to the full disk flux from both plage and active network emission. The 27-day modulation of the ultraviolet flux is explained by the evolution and rotation of the plage regions on the solar disc. Over the longer time scale of the eleven-year cycle it is essential that changes in the active network arising from the decay of plage regions also be considered as a source of ultraviolet flux variability. Only by using a three-component model of the solar flux is it possible to simultaneously reproduce the 27-day variability observed by the solar backscatter ultraviolet experiment on the Nimbus 7 satellite and the changes from the minimum to the maximum of the solar activity cycle observed by the rocket experiments of the Laboratory for Atmospheric and Space Physics and by the extreme ultraviolet spectrometer on the Atmospheric Explorer E satellite. It is shown that the AE-E experiment measured a smaller solar cycle variability for the ultraviolet irradiances than is predicted by the model calculations because of the spatially restricted field of view of this instrument.

AR-063

Lovelock, J.E., and G.J. FERBER. Exotic tracers for atmospheric studies. Atmospheric Environment 16(6):1467-1471 (1982).

Tracer materials can be injected into the atmosphere to study transport and dispersion processes and to validate air pollution model calculations. Tracers should be inert, non-toxic and harmless to the environment. Tracers for long-range experiments, where dilution is very great, must be measurable at extremely low concentrations, well below the parts per trillon level. Compounds suitable for long-range tracer work are rare and efforts should be made to reserve them for meteorological studies, barring them from commercial uses which would increase atmospheric background concentrations. The use of these exotic tracers, including certain perfluorocarbons and isotopically labelled methanes, should be coordinated within the meteorological community to minimize interferences and maximize research benefits.

AR-064
Malm, W., M. PITCHFORD, and A. Pitchford. Site specific factors in influencing the visual range calculated from teleradiometer measurements. Atmospheric Environment 16:2323-2333 (1982).

This paper presents conclusions and recommendations on the intepretation of data gathered from tele-radiometers. As part of Project VIEW (Visibility Investigation Experiment in the West), multi-wave-length teleradiometers were used to measure apparent target contrast in 14 southwestern national parks and monuments. Statistical results show that the accurate measurement of visual ranges by teleradiometer in an atmosphere containing significant amounts of aersol depends on observer-target distance and observation angle, and in clean atmospheres on inherent contrast. Target illumination, sun angle, and mean altitude of the sight path may also affect visual range. The relative contribution of each of these factors to the variance in calculated visual range at different sites as a function of air pollution levels is examined through the use of principal component and regression analysis.

AR-065
MATT, D. R., D. D. BALDOCCHI, B. A. HUTCHISON, and R. T. MCMILLEN. Comparison of radiation fluxes in a fully-leafed and leafless deciduous forest. Preprints, 16th Agricultural and Forest Meteorological Conference, April 26-28, 1983, Ft. Collins, Colorado. American Meteorological Society, Boston, 200-203 (1983).

Fluxes of electromagnetic radiation were measured in three wavebands (0.4 to 0.7, 0.3 to 2.8, and 0.3 to 60.0 microns) at six levels within and two levels above a mixed species deciduous forest. Two 33.5 m triangular towers 35 m apart support cables on which instrumented trams traverse. Spatially averaged fluxes of incoming radiation are presented for the fully leafed and leafless forest.

AR-066
MC FEE, C. and B. G. MENDONCA. Geophysical Monitoring for Climatic Change, Amundsen-Scott South Pole Station, 1981. Antarctic Journal of the United States, 1982 Review, XVIII(5):221-222 (1982).

No abstract.

AR-067
MCMILLEN, R. T. Eddy correlation calculations done in real-time. Preprints, Fire and Forest Meteorology Conference, April 15, 1983, Ft. Collins, Colorado. American Meteorological Society, Boston, 111-114 (1983).

Turbulent wind data were collected above an oak-hickory forest canopy located in irregular terrain in East Tennessee. The data were processed in two distinct ways and the results compared. The first technique involved a three-dimensional coordinate rotation, followed by the accepted method of calculating turbulent fluxes at more ideal sites. The second technique involves real-time mean removal with digital recursive filters, and real-time calculation of the turbulent fluxes. Stability of the solution is examined as a function of the mean removal filter time constant and the accumulation period of the solution.

AR-068
MCMILLEN, R. T., M. J. VANHOESEN, and R. P. HOSKER, JR. Real-time plots of vertical meteorological profiles using a balloon-borne telemetry system. Preprints, Fifth Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Canada. American Meteorological Society, Boston, 161-164 (1983).

Simultaneous real-time CRT plots of vertical profiles of PBL variables such as wind speed, direction, and temperature can routinely be produced by a portable computer connected to a commercially available balloon-borne telemetry system. Selected numerical data are printed out, and all data are recorded on digital tape cassettes, simplifying later playback and editing. After a flight the CRT profiles are

reproduced by the printer to provide a labeled permanent record of the run, facilitating flight-to-flight data comparisons. The hardware and programming of this new system are described, and sample results are shown. The system has been successfully used during two ASCOT expeditions and in a continuing PBL development study.

AR-069
  MILLER, J.M., D.H. Pack, and K. TELEGADAS. The pH of precipitation in the Washington, D.C., area: 1975-1981. NOAA-TM-ERL-ARL-118 (PB83-207852), 30 pp. (1983).

  In 1974, a local precipitation chemistry network, manned by members of the Air Resources Laboratories' staff, was set up in the Washington, D.C., area. Ten different sites, located at the members' homes, were used over the period, with six to eight being active at any one time. The samples were collected either in a plastic rain gauge or in a polyethelene funnel collector on a daily basis and were analyzed for pH and conductivity as soon as it was logistically possible. Selected samples from the Pack site were sent to the University of Virginia for full chemical analysis. The following two conclusions can be reached from the 7-year pH measurement effort. First, a seasonal variation of pH exists, i.e., the acidity of precipitation is higher in summer than in winter. Second, the acidity of precipitation has decreased, at least in the D.C. area, from an average of 82 μmol/l (pH = 4.09) of H^+ to an average of 42 μmol/l (pH = 4.38) of H^+ in 1981.

AR-070
  MILLER, S. W., and B. A. BODHAINE. Calibration of Pollak condensation nuclei counters using charged, monodisperse aerosols. Journal of Aerosol Science 13(5):419-428 (1982).

  Three Pollak condensation nuclei counters were calibrated separately using a commercially available aerosol source which produces a uniform, singly charged, monodisperse aerosol. Sodium chloride and ammonium sulfate aerosols of five particle sizes in the range of 0.0204-0.0730 μm were produced using an electrostatic classifier in concentrations from 5125 cm^{-3} to 1.121 x 10^6 cm^{-3}. The aerosol concentrations were corrected for doubly charged particles as well as for pressure effects in the Pollak counter. The greatest difference of the three instruments from the aerosol source was 24% below the source at 10^4 particles/cm^3. These counts were also found to be within 10% of those made with a Pollak counter maintained at the State University of New York, Albany. This agreement of three instruments to an independent aerosol source and to an accepted standard proves that Pollak counters, constructed according to Pollak's specifications, can measure particle concentrations reliably, and that the original calibrations provided by Pollak can be used without significant alteration.

AR-071
  MILLER, S. W., and B. A. BODHAINE. Supersaturation and expansion ratios in condensation nuclei counters: An historical perspective. Journal of Aerosol Science 13(6):481-490 (1982).

  A review of the development of the science of counting condensation nuclei with emphasis on the Nolan-Pollak counter is presented from John Aitken's original work to the present. The concept of supersaturation and its relationship to the counting of nuclei is investigated. Published expansion and supersaturation ratios are compared for several instruments used today and in the past, and a consistent method of calculating supersaturation is presented.

AR-072
  NAPPO, C. J. Methods of estimating meteorological representativeness. Preprints, Fifth Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Canada. American Meteorological Society, Boston, 246-252 (1983).

  The need to estimate the representativeness of atmospheric measurements exists in all branches of meteorology; however, because of the wise diversity of applications of these measurements, a consistent methodology for treating representativeness has not been developed. This paper presents a general definition of representativeness and describes several types of representativeness. Several methods of assessing representativeness are proposed and examples using real data are given. While estimates of representativeness can be determined, it is noted that representativeness is highly dependent upon the nature of a specific application. What may be a representative measurement in one context may not be in another; and although representativeness may be established in a statistical sense, the possibility exists that individual measurements may not be representative.

AR-073

NAPPO, C. J. The representativeness of meteorological observations. Proceedings, Advisory Workshop on Methods for Comparing Precipitation Chemistry Data, August 10-12, 1982, Rensselaerville, New York. Sigma Research Inc., Richland, Washington, 4-67 to 4-82 (1983).

A general definition is presented and several types of representativeness are outlined. Types of representativeness include measurement, point-to-point, point-to-volume, and temporal. The relation between the space-time variability of meteorological fields and representativeness is discussed. Possible measures of representativeness are detailed. It is concluded that representativeness is a stochastic and relative concept which varies according to user applications and meteorological quantity. What may be a representative measurement for one purpose may not be for another purpose; and even though a set of measurements may be representative in an ensemble sense, individual elements of the set may not be representative.

AR-074

NAPPO, C. J. Turbulence parameters derived from smoke-plume photoanalysis. Preprints, Sixth Symposium on Turbulence and Diffusion, March 22-25, 1983, Boston, Massachusetts. American Meteorological Society, Boston, 329-332 (1983).

For a variety of field and wind tunnel applications, it is highly desirable to be able to measure the turbulence characteristics of a flow without the need of fast-response wind measuring equipment. The use of smoke as an atmospheric tracer provides the means by which turbulence parameters can be calculated using the results of homogeneous turbulence diffusion theory. These parameters include Lagrangian integral time scale Γ_L, crosswind velocity variance σ_V^2, eddy diffusivity κ, eddy dissipation rate ϵ, and turbulence intensity i. This can be done because, as previously demonstrated (Nappo 1979, 1980), instantaneous and time-averaged dispersion parameters, σ_I and σ_T respectively, can be determined through analyses of instantaneous and time-averaged smoke-plume photographs using Gifford's (1959) smoke-plume theory. In effect, the diffusion problem is solved backwards; i.e., the observed atmospheric turbulence parameters appearing in diffusion theories. In order to demonstrate the utility and accuracy of the smoke-plume method, a test of the method was conducted in January, 1981, in the large wind tunnel of the U.S. Environmental Protection Agency's Fluid Modeling Facility located at Research Triangle Park, N.C. For a complete description of this facility and its operating characteristics see Snyder (1979). This note describes the results of this experiment and the methods used to calculate σ_I, σ_T, Γ_L, σ_V^2, κ, ϵ, and i, and demonstrates that the smoke-plume method is accurate and is apparently quite suitable for routine field and laboratory use.

AR-075

OLTMANS, S. J., and J. London. The quasi-biennial oscillation in atmospheric ozone. Journal of Geophysical Research 87(11):8981-8989 (1982).

Analysis of various characteristics of the statistical spectra of total ozone covering a 15 year period (1964-1978), and of ozone in the stratosphere over a period of about 7 years, indicates that the strong QBO in the zonal winds of the tropical stratosphere is associated with a detectable, although often weak, signal in total ozone and the ozone concentration in the lower and middle stratosphere. The region of strongest relationship between tropical stratospheric zonal winds and total ozone (e.g., maximum ozone associated with strong west winds) is in the tropics, mid-latitudes of the southern hemisphere, and, apparently, at high latitudes of the northern hemisphere. The observed period of the ozone QBO decreases from 27 months at the equator to about 24 months in mid-latitudes possibly due to local modification of the QBO, as it propagates poleward. In the tropics the ozone variation appears to be nearly in phase with the tropical wind QBO while at middle and high latitudes of the northern hemisphere and mid-latitudes of the southern hemisphere and ozone oscillation seems to lag the wind oscillation by about 12-14 months. The out-of-phase relationship at middle and high latitudes suggests a possible interaction between the tropical stratosphere QBO in zonal winds and the annual variation in poleward transport of ozone by quasi-horizontal eddies.

AR-076

Payne, A. W., Jr., W. H. SNYDER, F. S. BINKOWSKI, and J. E. Watson, Jr. Diffusion in the vicinity of standard-design nuclear power plants. Part I. Wind tunnel evaluation of diffusive characteristics of a simulated suburban neutral atmospheric boundary layer. Health Physics 43:813-827 (1982).

A large meteorological wind tunnel was used to simulate a suburban atmospheric boundary layer. The model-prototype scale was 1:300 and the roughness length was approximately 1.0 m full scale. The model boundary layer simulated full scale dispersion from ground-level and elevated release points over surfaces

of comparable roughness length. This information should prove useful in a variety of transport and diffusion studies over short to moderate downwind distances. It will be used in Part II as the baseline data set with which to compare diffusion downwind of standard-design nuclear power plants.

AR-077
PAYNE, A. W., Jr., W. H. SNYDER, F. S. BINKOWSKI, and J. E. Watson, Jr. Diffusion in the vicinity of standard-design nuclear power plants. Part II. Wind tunnel evaluation of building-wake characteristics, Health Physics 43:829-844 (1982).

Laboratory experiments were conducted to simulate radiopollutant effluents released to the atmosphere from two standard-design nuclear power plants. The main objective of the study was to compare the dispersion in the wakes of the plants with that in a simulated atmospheric boundary layer. Dispersion functions are determined that describe the spread of the effluent plume in the wake of each plant. These dispersion functions are described by power laws. They are determined for three incident wind angles and the number of stacks associated with each plant. Lateral plume spread was directly related to the silhouette area of the plants. A graphical technique is presented relating the lateral dispersion to the associated silhouette area of the building or building complex.

AR-078
PENDERGRASS, W. R., and S. P. S. Arya. Vortex development in boundary layer flows over two-dimensional ramps. Preprints, Sixth Symposium on Turbulence and Diffusion, March 22-25, 1983, Boston, Massachusetts. American Meteorological Society, Boston, 333-336 (1983).

Pulse wire and hot wire measurements of velocity field were made in the EPA meteorological wind tunnel to describe the vortex development over several two-dimensional ramps with slopes varying from 14° to 90°. In order to fully describe the flow in the recirculating region ahead of the ramp and the separated flow on top of the ramp, pulse wire measurements were made for both the longitudinal (u) and vertical (w) components. The two-dimensional ramp was immersed in a fully developed rural type simulated boundary layer with ramp height approximately 25% of the boundary layer height. Hot wire measurements were made ahead of the slope to describe the undisturbed flow. Combined with the pulse wire data, the flow ahead and over the ramp can be fully described. Longitudinal profiles of σ_u, σ_v, and σ_w were constructed; they show a smooth variation in the turbulent quantities with distance both ahead and after the ramp. Mean velocity components also show a smooth variation with distance, easily described by a simple linear type relationship. Using the vertical profiles of velocity, streamline patterns were constructed for each ramp to describe the windward vortex and separated flow after the ramp. For example, the vortex upwind of 90° ramp is well developed with base approximately the ramp height and vertical dimension approximately one-half the ramp height (H). The top of the vortex reflects the intermittent nature and strong vertical component near the separation point. At the top of the 90° ramp the separated flow was approximately 2H in length and .25H in depth. The vortex center was placed approximately .5H from the ramp edge and .1H from the surface. Flow separation at the top occurred only for ramp slopes greater than 30°. Using the combination of longitudinal and vertical components, the vector product was obtained to describe the flow pattern in the recirculation regions. For each ramp the maximum speed-up in the mean flow was calculated. The speed-up factor is found to increase with the increase in the ramp slope up to about 45° and to remain approximately constant for steeper ramps.

AR-079
PETERSEN, W. B., J. S. IRWIN, D. B. TURNER, J. A. Catalano, and F. V. Hale III. Handbook for preparing user's guides for air quality models. EPA-600/8-83-018, Environmental Science Research Laboratory, Research Triangle Park, N.C., 47pp. (1983).

Suggestions for content, order of material, style, and format are set forth for modelers to follow when writing user's guides for air quality models. A review of coding techniques conducive to model documentation is presented. This material was compiled by the Meteorology and Assessment Division, Environmental Sciences Research Laboratory, U.S. Environmental Protection Agency, to promote consistency among the user's guides.

AR-080
PETERSON, J. T., and K. J. HANSON. Report of Mount Kenya feasibility study. WMO/Environmental Pollution Monitoring Programme No. 12, Chapter 6, World Meteorological Organization, Geneva, 107-113 (1983).

No Abstract.

AR-081
  POSSIEL, N. C., and W. P. FREAS. Northeast corridor regional modeling project--Description of the 1980
  urban field studies. EPA-450/4-82-018, Office of Air Quality Planning and Standards, Research Triangle
  Park, N.C., 60 pp. (1982).

  This report describes the design and operation of the 1980 Field Studies conducted as part of the
Northeast Corridor Regional Modeling Project (NECRMP). The NECRMP is a multiphase program involving EPA
and State/local agencies in the development of the Regional Oxidant Model and its application to the
Northeastern United States. The 1980 Urban Field Studies were conducted to provide the data base of air
quality and meteorological measurements necessary for modeling the major Corridor cities: Washington,
Baltimore, New York and Boston. [A data base for modeling Philadelphia was acquired in 1979.] The 1980
field studies included continuous surface measurements of ozone, nitrogen oxides, hydrocarbons, wind
speed, wind direction, temperature, and solar radiation in the vicinity of these cities. In addition,
special measurements of hydrocarbon species, aircraft monitoring flights, sodars, pilot balloon obser-
vations, and rawinsonde soundings were employed to obtain air quality and meteorological measurements
aloft in the Corridor. Quality assurance procedures conducted as part of the data collection/reduction
tasks are also described in the report. Lists of the designated NECRMP monitoring sites and the
dates/times of species sample collection and of measurements aloft are provided in the appendices.

AR-082
  PUESCHEL, R. F. Aerosol measurements in the boundary layer. Prepared for the AMS Short Course on
  Instruments and Techniques for Probing the Atmosphere Boundary Layer (1983).

  No abstract.

AR-083
  PUESCHEL, R. F. Background Air Pollution Monitoring (BAPMoN): An international program of national
  responsibilities and benefits (1983).

  No abstract.

AR-084
  PUESCHEL, R. F. Effects of sulfur compounds and other pollutants on visibility. Environmental
  Pollution Monitoring Programme Report No. 14, World Meterological Organization (1983).

  No abstract.

AR-085
  PUESCHEL, R. F., E. W. BARRETT, C. C. VAN VALIN, and D. L. WELLMAN. Boundary layer aerosols:
  Alterations by power plant pollutants. Proceedings, 6th Air Quality World Congress (1983).

  During the past several years, in-situ measurements with airborne optical particle spectrometers were
performed in the vicinity of coal-fired powerplants in Utah and New Mexico. Data analysis involves least-
square fitting of modified gamma distributions to the spectrometer data points, and integration of the
curves to derive the statistics of the number, surface area and mass distributions. Typically, in the
size range from 0.05 to 23.5 µm particle radius, the size distributions are bimodal with a small-particle
mode near 0.1 µm and a large-particle mode between 4.0 and 7.0 µm. Plume aerosol surface area is enhanced
up to four orders of magnitude above background in the plumes of older plants, but only by a factor of up
to five in plumes that are subjected to stricter emission controls. These differences reflect the effec-
tiveness of pollution emission control technolgies, viz., electrostatic precipitation versus electrostatic
precipitation followed by wet lime scrubbing. Aerosols were also collected on board the aircraft on
Nuclepore filters, for subsequent analysis by scanning electron microscopy and X-ray energy spectrometry.
The resulting information on shape, size and elemental composition of individual particles permits conclu-
sions regarding the mechanisms of their formation, transformation, and their meteorological effects.
Results show that about half of the flyash particles accumulate sulfur on their surface. This renders the
particles hygroscopic and enhances their cloud and haze forming capabilities at sufficiently high relative
humidities. The total mass of sulfur on flyash is too small, however, to postulate a catalytic effect of
flyash on the heterogeneous conversion of sulfur dioxide to sulfate. In coal-fired powerplant plumes,
homogeneous nucleation at low rates determines the formation of small sulfate particles that are subject
to long-range transport. As a consequence, sulfur mixed with silicates is found and dominates the small-
particle mode even in remote areas. High acidity corresponding to pH values as low as 3.8 in clouds at 3
km over the Great Plains in Colorado has been linked to the presence of sulfates in the upper troposphere.

Efficient control of sulfur gas emissions must be accomplished if the accumulation of sulfur in the small-particle mode is to be avoided.

AR-086
PUESCHEL, R. F., and E. W. BARRETT. Sulfate in the atmospheric boundary layer: Concentration and mechanisms of formation. American Geophysical Union, Geophysical Monograph Series 26 (1982).

Data on particulate sulfur in a coal-fired power plant plume and on its long-range transport are presented in relation to the total aerosol. The primary plume aerosol that could provide potential catalytic surfaces for sulfate generation is fly ash. Its surface area was determined in situ by Knollenberg optical particle counters. Surface features and the spatial distribution of elements in individual fly ash particles were determined by scanning electron microscopy and X-ray energy dispersive analysis of airborne samples. The results provide evidence of a selective accumulation of sulfate on the surface on some fly ash particles. The amount of sulfate thus formed, however, is only about 2 percent of the total mass. Hence, fly ash has little catalytic effect on the heterogeneous conversion of SO_2 to $SO_4^=$ above currently accepted rates of 1 percent per hour. Homogeneous nucleation at low rates appears to be equally important for the generation of small sulfate particles that are subject to long-range transport. This finding was confirmed by measurements in east-central Utah, a region of the contiguous U.S. that historically is characterized by excellent atmospheric clarity. Although the total particle mass of the background aerosol in Utah is 2 orders of magnitude less than in the Four Corners area, the small-particle mode is dominated by silicon and sulfur. The spherical shape of these silicon- and sulfur-containing particles indicates that a phase transition was involved in the mechanism of their formation. The increase in sulfur aerosols with height suggests their advection from remote sources. It appears that silicon is as good a tracer for a primary combustion aerosol as is sulfur for a secondary aerosol.

AR-087
PUESCHEL, R. F., E. W. BARRETT, and E. GANOR. Long-range transport and effects on clouds of sulfur-containing aerosols. EOS 63(45):894 (1982).

Aerosol and cloud-drop spectra between 0.05 and 23.5 micrometer particle radius were measured with PMS optical spectrometers on White Face Mountain, NY in summer 1981. The aerosol concentration in the small-particle mode, typically found at around 0.1 micrometer radius, was less than 100 per cubic centimeter in air masses that originated over the north Atlantic. It increased to several hundred in west-northwesterly flows and to several thousands per cubic centimeter in air masses that came out of the Ohio valley. Effects on clouds were an increase in the cloud drop concentrations, and a decrease of the cloud drop modal radii at higher particle concentration, suggesting that small pollutant particles played an important role in the cloud nucleation process. This effect on the cloud colloidal stability was not reflected in the cloud liquid water content which varied between 0.007 and 1.0 grams per cubic meter, irrespective of the air mass trajectories. X-ray energy dispersive analysis of individual particle revealed sulfur in up to 90 percent (by number) of small particle in polluted and in about 50 percent in non-polluted air.

AR-088
RAO, K. S. Analytical solutions of a gradient-transfer model for plume deposition and sedimentation. EPA-600/S3-82-079, Environmental Sciences Research Lab., Research Triangle Park, N.C. (1982).

This report reviews the methods available in the literature for including dry deposition in a Gaussian plume model. A gradient-transfer or K-theory model for the atmospheric transport and ground deposition of gaseous and particulate pollutants emitted from an elevated continuous point source is outlined. This analytical plume model treats gravitational settling and dry deposition in a physically realistic and more straightforward manner than other approaches. For practical application of the model, the eddy diffusivity coefficients in the analytical solutions are expressed in terms of the widely-used Gaussian plume dispersion parameters. The latter can be specified as functions of the downwind distance and the atmospheric stability class within the framework of the standard turbulence-typing schemes. The analytical plume diffusion-deposition solutions are presented for various stability and mixing conditions. In the limit when settling and deposition velocities are zero, these equations reduce to the well-known Gaussian plume diffusion algorithms presently used in EPA models. Thus the analytical model for estimating deposition described here retains the ease of application associated with Gaussian plume models, and is subject to the same basic assumptions and limitations as the latter. The deposition model has been applied to particulate pollutants with appreciable settling velocity and to gases which deposit on ground without settling. Calculated results of ground-level concentrations, vertical concentration profiles, surface deposition fluxes, and net deposition and suspension ratios are presented. The atmospheric stability and the magnitude of deposition velocity are shown to have significant effects on these results. The specification of gravitational settling and deposition velocities in the model is discussed. A field study is proposed to measure one or more of the model parameters, and to provide a good data set for model

validation over a 10 km distance from the source. The proposed field experiment is based on a modified Bowen ratio-turbulent variance approach, and it avoids the difficulties associated with the vertical gradient and eddy-correlation methods of surface flux measurements.

AR-089

RAO, K. S., and C. J. NAPPO. Comparison of observations and model predictions of nocturnal drainage flow over a simple slope. Preprints, Sixth Symposium on Turbulence and Diffusion, March 22-23, 1983, Boston, Massachusetts. American Meteorological Society, Boston, 184-187 (1983).

Observations of nocturnal drainage flows over a nearly two-dimensional slope on Rattlesnake Mountain near Richland, Washington, were reported by Doran and Horst (1982). Vertical profiles of wind and temperature were measured by tower-mounted instruments at three downslope locations during several nights of 1980 and 1981. A tethersonde was used to measure the ambient wind conditions above the drainage layer. These detailed observations provide a rare and unique data set to validate models of drainage flows over simple finite slopes. A two-dimensional time-dependent drainage flow model, developed at ATDL as part of DOE's ASCOT program, has been used to simulate these observations. The model, which is an extension of the one-dimensional drainage flow model of Rao and Snodgrass (1981), is based on a turbulent kinetic energy closure and predicts the mean wind and temperature profiles, turbulent fluxes, and depth of the drainage flow. Several slope flow models in the literature (e.g., Manins and Sawford, 1979; Briggs, 1979) use an extended hydraulic approach which lacks a detailed treatment of the vertical structure. The entrainment effects are parameterized in these models in terms of an entrainment coefficient which is based on the laboratory data of Ellison and Turner (1959). The parameters derived from the latter experiments may be be directly applicable to atmospheric conditions. A major limitation of these models is their failure to include the effects of ambient winds on the drainage flow. The present numerical model provides information on the vertical variation as well as the downslope development of the flow as a function of time. The entrainment effects are implicitly included through the continuity equation instead of being specified through external parameterizations. Further, the model can account for the effects of any known variation of the ambient wind speed and direction on the drainage flow development. This paper presents a brief description of the model, and shows results of its simulation of two selected study cases of the drainage flow observations, one each from the '80 and '81 Rattlesnake Mountain data. The two cases have significantly different ambient wind conditions and surface inversion strengths. In both cases, a well-developed drainage flow with a prominent velocity maximum near the surface has been observed. The model predictions of velocity and temperature profiles at the three towers, and the depth of the drainage flow show excellent agreement with observations in each case.

AR-090

RAO, K. S., and L. SATTERFIELD. A study of the probable environmental impact of fugitive coal dust emissions at the Ravenswood Power Plant, New York. NOAA-TM-ERL-ARL-123, 83 pp. (1983).

The Ravenswood Power Plant of the Consolidated Edison Company of New York is being converted to use coal as the primary fuel. This report addresses the probable short and long-term air pollution impacts of the fugitive coal dust emissions that are likely to occur during the coal unloading at the facility. The coal drift consists of particles ranging in size from 0.1 to 200 µm. Assuming a lognormal probability of the particle size distribution, a drift mass spectrum was developed for six particle size ranges considered in the study. A steady state atmospheric advection-diffusion model that accounts for the gravitational settling and dry deposition of the particles was formulated, and an exact analytical solution, consistent with the basic assumptions of the Gaussian plume model, was derived and applied to the present study. The meteorological data used consists of a five year record of hourly surface wind observations. Six wind speed classes and sixteen wind direction classes were considered in the analysis. This study considers two different coal unloading schedules: coal is unloaded only during daytime (0700-1900 hrs.) in Case I, and around the clock (both day and night), in Case II. The calculated results of ground-level concentrations, atmospheric concentrations and visibilities, hourly surface deposition fluxes, and deposition flux and net deposition rates on monthly and yearly basis were presented for Cases I and II separately.

AR-091

RAO, K. S., and L. SATTERFIELD. User's model for MPTER Model modifications for dry deposition of gaseous and particulate pollutants. EPA-600/S8-82-024, Environmental Sciences Research Lab., Research Triangle Park, N.C. (1982).

MPTER is the designation for a multiple point source algorithm with terrain adjustments. The diffusion algorithm is based upon Gaussian plume modeling assumptions. The MPTER model can be used for estimating air pollutant concentrations from multiple sources in rural environments. The model has technical input options for terrain adjustment, stack downwash, gradual plume rise, and buoyancy-induced dispersion, and a

great variety of output options. The MPTER model, therefore, may be considered a research tool for exploratory use of various assumptions and parameter values. This report is a User's Guide to MPTER-DS model which can explicitly account for dry deposition of gaseous and suspended particulate pollutants in the plume. The MPTER-DS model utilizes the Gaussian plume-type diffussion-deposition algorithms based on analytical solutions of a gradient-transfer model. These algorithms are easy to apply and, in the limit when pollutant settling and deposition velocities are zero, they reduce to the usual Gaussian plume diffusion algorithms in the MPTER model. This report outlines the modifications of the MPTER computer program to include deposition. The information is oriented to the model user and the programmer. This report is not a complete User's Guide to the MPTER-DS model; it should be used as a supplement to the original User's Guide for MPTER.

AR-092
  RAO, K. S., and H. F. Snodgrass. User's guide for PAL Model modifications for dry deposition of gaseous and particulate pollutants. EPA-600/S8-82-023, Environmental Sciences Research Lab., Research Triangle Park, N.C. (1982).

  PAL is an acronym for a model which applies a Gaussian plume diffusion algorithm to point, area, and line sources. The model can be used for estimating hourly and short-term average concentrations of non-reactive pollutants at multiple receptors from several sources of each type. PAL is intended to assess the impact on air quality, on scales of tens of meters to several kilometers, of portions of urban areas such as shopping centers, large parking areas, and airports. Level terrain is assumed, and pollutant removal processes are ignored. This report is a User's Guide to the PAL-DS model that utilizes Gaussian plume-type diffusion-deposition algorithms based on analytical solutions of a gradient-transfer model. The PAL-DS model can treat deposition of both gaseous and suspended particulate pollutants in the plume since gravitational settling and dry deposition of the particles are explicitly accounted for. The analytical diffusion-deposition expressions listed in this report are easy to apply and, in the limit when pollutant settling and deposition velocities are zero, they reduce to the usual Gaussian plume diffusion algorithms in the PAL model. This report outlines the modifications of the PAL computer program to include deposition. The information is oriented to the model user and the programmer. This report is not a complete User's Guide to the PAL-DS model; it should be used as a supplement to the original User's Guide. for PAL.

AR-093
  Rasmussen, R. A., M. A. K. Khalil, and R. J. FOX. Altitudinal and temporal variation of hydrocarbons and other gaseous tracers of arctic haze. Geophysical Research Letters 10(2):144-147 (1983).

  Springtime concentrations of hydrocarbons and chlorocarbons in the arctic atmosphere (70°N, Barrow) are reported. Concentrations of the following gases were determined: acetylene (C_2H_2), ethene (C_2H_4), ethane (C_2H_6), propane (C_3H_8), benzene (C_6H_6), toluene (C_7H_8), perchloroethylene (C_2Cl_4), and trichloroethylene (C_2HCl_3). Vertical distributions of these gases were also determined on flights during May 1982. The results show that C_2Cl_4, C_2H_2, and C_2H_6 may be gaseous tracers of arctic haze. Their vertical profiles suggest that polluted air may be transported to the arctic 1-2 km above ground, and perhaps also in layers higher than this level.

AR-094
  Schnell, R. C., PUESCHEL, R. F., and D. L. WELLMAN. Ice nucleus characteristics of Mount St. Helens effluents. Journal of Geophysical Research 87(C13):11109-11112 (1982).

  Aerosols were studied in situ and captured on membrane filters from an aircraft flown around Mount St. Helens during its phreatic period in April 1980. Bulk samples of volcanic ash were collected at ground level 120 km downwind on May 19,1980 and reaerosolized in a laboratory in ash cloud simulation studies. The aerosol and/or ash samples were tested for ice nucleus (IN) activity using four different IN measurement systems (NCAR acoustical counter, bulk drop freezing, NCAR dynamic thermal diffusion chamber, and filter drop freezing). Although threshold IN activity was observed at -8 degree C in bulk ash, in aerosols there were few IN active at temperatures warmer than -12 degree C. At -12 degree C, IN concentrations were less than 0.4 1^{-1} (400 m^{-3}) even when the aerosol concentrations were as high at 3000 µg m^{-3}. At aerosol concentrations of 500 µg m^{-3} and less, the IN content of the ash was below background threshold temperatures of -18 degree C.

AR-095
  SHREFFLER, J. H. Intercomparison of surface and upper air winds in an urban area. Boundary-Layer Meteorology 24:345-356 (1982).

During the Regional Air Pollution Study (RAPS), winds in the St. Louis region were recorded by surface stations (hourly averages) and by multiple upper air releases (on-the-hour). This study analyzes differences (1) between upper air and surface resultant winds, (2) among upper air winds at 4 sites, and (3) among surface winds at 25 sites. The extensive data set provides a statistical basis for indicating the representativeness of individual observations, and the results show considerable variation between simultaneously-measured winds determined by alternate means. Based on Gaussian plume dispersion, the spatial variations in wind direction are translated into expected departures between predictions and observations of pollutant concentrations. Inaccurate specification of winds in air quality simulation models is likely to be a substantial contributor to differences between short-term predictions and observations on an urban scale.

AR-096

SIEVERING, H., E. W. BARRETT, C. VAN VALIN, and R. F. PUESCHEL. In-cloud aerosol sulfur removal: A case study. CACGP Symposium on Tropospheric Chemistry, Oxford, England (1983).

Theoretical estimates of sulfate (SO_4) removal by precipitation have assumed (with essentially no supporting field data) that 30-100% of available clear air SO_4 is ingested into cloud water. We report here two measurements of in-cloud sulfur removal for a background aerosol air mass with $SO_4 < 1$ µg m^{-3}. The experiment was performed at 300m AGL on the Boulder Atmospheric Observatory (BAO) tower located 40 km east of the Rocky Mountains and 40 km north of Denver, CO. Fine fraction (D $\gtrsim$ 3 µm) particulate matter was collected to afford 1-hr increment data analysis for sulfur and soil (here, a composite of Al, Ca, Fe, Si, K, and Ti) by PIXE analysis. Optical particle spectrometer probes afforded the determination of accumulation mode (small) particle number distribution and mass, cloud presence and large particle (cloud) number distribution and liquid water content. Cloud cover predominated during the three-day mountain upslope event with cloud base usually above the 300m tower. However, two cases of in-cloud sampling, one 7-hr and one 5-hr long, were obtained. 80% to 95% (by mass) sulfur removal was observed during the two liquid phase cloud events (5-20% interstitial sulfur remains). In contrast to the 80-95% sulfur removal, only 35-75% of the soil mass was removed. During the first cloud event the total accumulation mode mass dropped from a clear air value of 1.5 µg m^{-3} to 0.2 µg m^{-3} in-cloud. This 7- to 8-fold aerosol mass reduction was found to be somewhat less than the reduction in sulfur, again suggesting soil material to have been less soluble than sulfur. The 80% removal of aerosol sulfur during two observed cloud events indicates that the efficiency of background SO_4 ingestion into cloud water may also be $\gtrsim$ 80% and supports the notion that scavenging may be the dominant source of precipitation SO_4 in background aerosol environments.

AR-097

SNYDER, W. H., R. S. Thompson, R. E. ESKRIDGE, R. E. LAWSON, Jr., I. P. Castro, J. T. Lee, J. C. R. Hunt, and Y. Ogawa. The structure of strongly stratified flow over hills: Dividing-streamline concept. EPA-600/3-83-015, Environmental Sciences Research Lab., Research Triangle Park, N.C., 375 pp. (1983).

The applicability of an integral formula for the dividing-streamline height in strongly stable flow over hills is tested in several laboratory experiments. The dividing-streamline concept is based upon simple energy arguments; fluid parcels originating far upstream of a hill at elevations HR above the dividing-streamline height Hs will have sufficient kinetic energy to rise over the top, whereas those below Hs must pass around the sides. The concept is found to be valid when interpreted as a necessary but not sufficient condition (i.e., a fluid parcel may possess sufficient kinetic energy to surmount a hill, but it does not necessarily do so) for wide ranges of hill shapes, density profile shapes, and wind angles, and in strong shear flows as well. Further, studies of strongly stratified flow over two-dimensional hills show that steady-state conditions are not established in a finitelength towing tank; these measurements also suggest that a very long tank would be required for steady-state conditions to be established upstream of long ridges with small gaps and cast doubt upon the validity of previous laboratory studies.

AR-098

STEARNS, L. P. Infrared cooling in cloudy atmospheres: Precision of grid point selection for numerical models. Notes and Correspondence, <u>Monthly Weather Review</u> 111(7):1501-1505 (1983).

The infrared layer temperature change in a cloudy atmosphere normally shows warming at the base of the cloud and intense cooling at the top of the cloud. In a model that uses broad-band radiative transfer to calculate atmospheric temperature changes, errors on the order of 6.0 K day^{-1} can occur at the top of a cloud if only selected grid points are used. Calculations using grid points at discrete intervals produce a smoothing effect over the entire cooling profile and increase errors. Two case studies were used to demonstrate these problems.

AR-099

STEARNS, L. P., and R. F. PUESCHEL. Infrared atmospheric extinction in a rural atmosphere. <u>EOS</u> 63(45): 900 (1982).

Radiometric measurement of haze volume atmospheric extinction coefficient in the atmospheric window (8-14 µm) were profiled from an aircraft in a persistent anticyclonic situation near coal-fired power plants to show the effects of a power plant on the local atmosphere and terrain. Simultaneous size spectra were generated by a particle probe. Linearity between the two measurements was noted, thus making possible the inference of extinction in the free atmosphere. Haze values of extinction ranged from .04 to .07 km^{-1} while the free air extinction was calculated to be .8E-3. Linearity between power plant plumes broke down, however with a bulk loading of 35.E3 µg m^{-3} and an extinction of .41 km^{-1}. Clear air only (water vapor, carbon dioxide and continuum) extinction averaged .09 $\pm$ .006 km^{-1} over the same time period at the same altitudes.

AR-100

STEARNS, L. P., and R. F. PUESCHEL. Infrared optical properties of a coal-fired power plant plume. <u>Applied</u> <u>Optics</u> 22:1856 (1983).

Infrared measurements in the 8-14 µm spectral region were made of two coal-fired power plant plumes and area haze in the Four Corners region of New Mexico from 1 to 7 Nov. 1980. The layer transmittance, optical depth, and volume extinction coefficient derived from measurements on four nonconsecutive days show the effects of the plumes on the IR optical properties of the atmosphere. The average contribution of the plume alone to the IR extinction coefficient was 74% at the Four Corners plant; the background haze contributed 7-11%. More efficient particulate emission control at the San Juan power plant reduced the average contribution of its plume to 57% of the extinction coefficient. The haze contributed an average of 16%. The results show an increase with time of the haze bulk extinction coefficient during a persistent anticyclonic synopotic situation. Extinction coefficients of the haze showed a linearity with particulate loading, which led to estimates of IR volume extinctions of the free troposphere from aerosol measurements.

AR-101

TURNER, D. B., and J. S. IRWIN. Comparison of sulfur dioxide estimates from the model RAM with St. Louis RAPS measurements. In <u>Air Pollution Modeling and Its Application</u>, <u>II</u>, C. De Wispelaere, (ed.), Plenum Publishing Corporation, New York, 695-707 (1983).

Estimates of SO_2 concentrations were made using the RAM model, with the meteorological input and emissions input specified hourly. The RAM is a Gaussian-plume multiple-source air quality simulation model appropriate for use in relatively flat urban aras. The highest SO_2 concentrations observed and estimated for averaging times from 1-hour to 1-year are presented for the St. Louis area in 1976. The St. Louis Regional Air Pollution Study (RAPS) data base provided the hourly emission rates for the 208 point sources and 1989 area sources used in the model computations. The 25 St. Louis Regional Air Monitoring Stations (RAMS), provided the data for specifying the hourly meteorological conditions. At 13 of the RAMS sites, SO_2 concentrations were measured. The resulting model evaluation data base for each hour includes calendar date, time, wind speed, wind direction, atmospheric stability class, mixing height, total point source emissions, total area source emissions, and 13 pairs of observed and estimated SO_2 concentrations. Tables are provided giving the highest, second-highest, fifth-highest, and tenth-highest SO_2 concentrations observed and estimated at the RAMS sites for 1976. For both second-highest 3-hour and 24-hour concentrations, the model underestimates concentrations at 9 of the 13 monitoring sites and also underestimates the network maximum. For annual concentrations (based on the hours of valid monitoring data at each monitor), the model overestimates the concentrations at 7 of the 13 monitoring sites and overestimates the network maximum by more than a factor of two.

AR-102

VAN DER HOVEN, I. Measured versus empirical techniques to determine the plume sigma-y for ground sources. NOAA-TM-ERL-ARL-120 (PB83-222570), 9 pp. (1983).

Three empirical techniques, namely, the $\Delta T/\Delta Z$, σ_θ, and $\Delta T/\Delta Z$ adjusted by a wind meander factor, were used to predict the crosswind plume concentration standard deviation (σ_y). Ratios of measured to predicted σ_y were formed. The $\Delta T/\Delta Z$ technique adjusted by a meander factor showed the best agreement with measured values.

AR-103
  VAN VALIN, C. C., R. F. PUESCHEL, E. W. BARRETT, and G. M. Williams. Field observations of stratified
  atmospheric flow above an obstacle. Boundary-Layer Meteorology 24:331-343 (1982).

  In a study using the plume from the Four Corners power plant, near Farmington, N.M., lee waves were
  observed during times when the plume flowed across the Hogback. Wavelengths were typically about 1.2 km;
  wave amplitudes were more variable, ranging from 20 to 100m. The observed amplitudes imply an obstacle
  that is broader and shallower than is actually the case. This is in agreement with laboratory studies
  that show the existence of regions of complex flow both upstream and downstream form an obstacle, which
  have the effect of broadening the region over which laminar flow occurs. Visual observation, measurement
  of the plume cross-sectional area both upstream and downstream from the Hogback, and measurement of plume
  aerosol concentrations show that turbulent and eddy flow over and downwind from the Hogback increase the
  rate of mixing of the plume with the surrounding atmosphere. This in turn increases the rate at which
  plume components come into contact with the ground.

AR-104
  VAN VALIN, C. C., L. P. STEARNS, C. T. NAGAMOTO, and R. F. PUESCHEL. Analysis results of rainwater and
  cloudwater samples. EOS 63(45):894 (1982).

  Rain and cloudwater samples collected at Boulder, CO. and at Whiteface Mountain, N.Y., were analyzed for
  several anions, ammonium cation, and several metals. This showed that the dissolved substance con-
  centration in rain or clouds is greatest in small, isolated systems or at the beginning of extended rain
  periods. The urban or industrial influence was readily detected in both the Boulder and Whiteface
  samples. Oxalate was detected in most samples; the analysis results suggest that the oxalate con-
  centration in rainwater is somewhat greater than in cloudwater.

AR-105
  VAN VALIN, C. C., D. L. WELLMAN, E. W. BARRETT, and L. P. STEARNS. Tower particle sampling
  measurements. Boulder Upslope Cloud Observation Experiment Report, E.E. Gossard, Ed. (1982).

  No abstract.

AR-106
  VIEBROCK, H. J. Fiscal year 1982 summary report of NOAA Meteorology Division support to the Environ-
  mental Protection Agency. NOAA-TM-ERL-ARL-117 (PB83-197269), 58 pp. (1983).

  The Meteorology Division provided research and meteorological support to the Environmental Protection
  Agency. Basic meteorological support consisted of the application of dispersion models and the conduct of
  dispersion studies and evaluations. The primary research effort was in the development and evaluation of
  air quality simulation models using numerical and physical techniques supported by field studies.
  Modeling emphasis was on the dispersion of photochemical oxidants on urban and regional scales, dis-
  persion in complex terrain, atmospheric processes in the boundary layer, and the review and assessment of
  dispersion model parameters. Activity highlights included conduct of a small hill study at Cinder Cone
  Butte, Idaho, and preparation for a second study at Hogback Ridge, New Mexico; completion of an initial
  regional oxidant model; four urban scale photochemical disperion models were evaluated; the final version
  of a Lagrangian long-range transport model (ENAMAP-1) was completed and applied to support the U.S./
  Canadian acid rain memorandum of intent activities; completion of the Fluid Modeling Facility of a
  Good-Engineering Practice (GEP) stack height demonstration study and the conduct of a series of experi-
  ments in the Fluid Modeling Facility to study the dividing streamline concept and to examine the effects
  of surface roughness on dispersion from tall stacks. Version 4 of UNAMAP, fortran source codes for air
  quality dispersion models, was made available; a handbook for preparing model user's guides was prepared;
  the exposure of commuters to CO was studied and modeled; work continued on improving the estimates of
  plume dispersion parameters; operation of a Model Clearinghouse continued; and objective procedures for
  estimating mixing heights were evaluated.

AR-107
  Weber, A. H., J. S. IRWIN, W. B. PETERSEN, J. J. Mathis, Jr., and J. P. Kahler. Spectral scales in the
  atmospheric boundary layer. Journal of Applied Meteorology 21:1622-1632 (1982).

Wind measurements from the Savannah River Laboratory-WJBF-TV tower in Beech Island, South Carolina were
used to compute turbulence parameters which were then compared with similarity theory predictions sum-
marized by Hanna (1981a). The parameters computed were standard deviations of the fluctuating velocity
components σ_u, σ_v and σ_w, and spectral scales λ and I. The correlation coefficients were highest for

the standard deviations of the velocity components σ_u, σ_v and σ_w. The averaged correlation coefficients for all three components were 0.60, 0.45 and 0.72 for unstable, stable and neutral conditions, respectively. The averaged correlation coefficients between computed and measured spectral maxima lmu, lmv and lmw were 0.66 stable conditions and 0.65 for neutral conditions. Very low correlations of -0.11 and 0.01 were obtained for λ_u and λ_v in unstable conditions. The vertical wavelength λ_w, however, had a correlation coefficient of 0.59 between measured and predicted values.

AR-108

Wesely, M. L., D. R. Cook. R. L. Hart, B. B. HICKS, J. L. Durham, R. E. Speer, D. H. Stedman, and R. J. Tropp. Eddy-correlation measurements of the dry deposition of particulate sulfur and submicron particles. Proceedings, Precipitation Scavenging, Dry Deposition, and Resuspension, Volume 2, November 29-December 3, 1982, Santa Monica, California. Elsevier Science Publishing Co., Inc., New York, 943-952 (1983).

The results of a five-year series of intensive micrometeorological experiments on deposition of small particles are reported. Deposition velocities are greatest over a coniferous forest, and smallest over a winter deciduous forest. The deposition velocity to grass is about 0.2 (± 0.1) cm/s, with somewhat greater values being appropriate for well-watered grass in unstable stratification (0.4 - 0.5 cm/s).

AO-001

Barnes, G. M., E. J. Zipser, D. P. JORGENSEN, and F. D. MARKS, JR. Mesoscale and convective-scale structure of a hurricane rainband. Journal of the Atmospheric Sciences 40:2125-2137 (1983).

The mesoscale thermodynamic, kinematic, and radar structure of a Hurricane Floyd rainband observed on 7 September 1981 is presented. Data are from 26 aircraft passes through the rainband from 150 to 6400 m. A composite technique which presents rainband structure as a function of distance from the storm circulation center reveals inflow from the outer edge of the band and a partial barrier to this flow below 3 km. In the direction parallel to rainband orientation, radar reveals cellular reflectivity structure on the upwind and central portions of the rainband; the frequency of cellular precipitation decreases in favor of stratiform precipitation further downwind as the band spirals gradually towards the eyewall. In the radial direction, a decrease of 12 K in θ_e is observed across the rainband in the subcloud layer. Convective scale up- and downdrafts that are associated with cellular reflectivity structure are hypothesized to be responsible for the thermodynamic modification of the cloud and sub-cloud layers.

AO-002

BEHRINGER, D. W. Simple advective beta spirals. Ocean Modelling 8-10 (1983).

No abstract.

AO-003

BEHRINGER, D. W., G. P. Knapp, R. J. Stanley, and H. M. Stommel. Hydrographic station data of five surveys of the beta-triangle in the eastern North Atlantic, 1978-1981. Technical Report WHOI-83-24 (1983).

This is a data report, giving temperature, salinity and dissolved oxygen data obtained during five surveys of the beta-triangle area of the eastern North Atlantic in the years 1979-1981. The report is divided into two parts. Part I consists of a listing of station data obtained on all stations occupied--on the periphery of the triangle, inside it, and some nearby stations outside it. Part II is a set of profiles of this data drawn on the three sides of the triangle, for easy reference and visual comparison. Detailed scientific study of the data is published elsewhere.

AO-004

BLACK, P. G. Ocean temperature changes induced by tropical cyclones. Ph.D. dissertation, The Pennsylvania State University, University Park, 278 pp. (1983).

Detailed analyses of airborne expendable bathythermograph (AXBT) and infrared radiation thermometer data have shown that hurricanes decrease sea surface temperature (SST) in a consistent pattern with respect to the hurricane center. The pattern of SST decreases is crescent-shaped, with largest decreases in the right rear quadrant of the storm between the radius of maximum wind (RMAX) and two times RMAX. Little or no SST decreases occur in the left front quadrant. As the value of RMAX increases, the SST decreases become greater. The magnitude of the SST decrease is nearly independent of storm speed (U) for U > 5 m/s, but increases nonlinearly as U decreases for U < 3.5 m/s. In addition, the magnitude of the SST decrease is a linear function of storm intensity for U < 3.5 m/s and for VMAX < 40 m/s. Otherwise, the magnitude of the SST decrease is independent of intensity. No significant SST decrease occurs at any storm speed or intensity for mixed layer depths (MLD) exceeding about 70 m. Maximum SST decreases greater than 5°C occur for storms moving slower than 2 m/s in regions of shallow MLD (30-40 m). The observations suggest that SST decreases continue at a location to the right of the storm track after the storm forcing has moved away. In the period from 0.6 to 1.4 days after storm passage, SST continues to decrease by 1-2°C. These continued decreases appear to be related to the shear-generated mixing at the base of the mixed layer associated with the clockwise rotation and acceleration of the mixed layer inertial currents induced by the storm. In addition, a residual vertical circulation appears to be sustained for some time after storm passage which continues to transport colder water upward beneath the storm track and warmer water downward beyond two times RMAX to the right of the track. The MLD decreases beneath the storm center begin with the passage of the positive wind stress curl (negative in the Southern Hemisphere) associated with the leading edge of the hurricane eyewall. The maximum MLD decrease is usually displaced to the rear of the storm center by a distance proportional to the speed of the storm. MLD increases are observed beyond RMAX to the right of the track, whereas there is very little change observed to the left of track. The maximum SST and mixed-

layer temperature (MLT) decreases to the right of the storm track are located over the region where the thermocline gradient is maximum. This is a transition region between the MLD decreases along the track and the MLD increases between RMAX and two RMAX. Following the initial response, the residual SST and MLD patterns are modulated by an internal, inertia-gravity wave response. Wake patterns at larger distances and longer periods (two to five inertial periods) after the storm passage reflect scales of variation consistent with inertial wavelengths. For some intense storms, a transition region exists on the order of one to two inertial wavelengths/periods, where a 100-200 km scale of variation in the SST and MLD patterns is most pronounced. It is speculated that this may be a harmonic of the longer inertial wavelength/period excited by finite amplitude effects due to the extreme magnitude of the forcing. Wind stress curl magnitudes were found to be an order of magnitude larger for mature storms than have been assumed in numerical models of ocean response. The crescent-shaped pattern of SST decreases and MLD increases suggests that mixing mechanisms which operate on short time scales are important. A three stage sequence of events is hypothesized to explain the observed pattern and subsequent changes. It is suggested that, initially, upward surface buoyancy flux and mechanically-generated turbulence through the wind stress are important mechanisms. It is suggested that near the storm center both mechanical generation and local shear production at the base of the mixed layer are important. Finally, enhancement of the mixing process may occur after storm passage for certain limited combinations of wind stress curl, radius of maximum wind, storm translational speed, ocean baroclinic wave speed, and latitude, which results in the generation of strong inertial currents that rotate in phase with the surface wind. Normally, however, the large mixed layer inertial currents required to produce shear-generated mixing occur too far to the rear of the storm to contribute to the crescent pattern near RMAX, but may contribute to the modulation of the pattern along the track. Cross-section analyses of temperature as a function of depth reveal consistent patterns of increases and decreases with respect to the storm center for various storm speeds. For sections normal to and through the center of slow-moving storms, and at inertial wave crests in the wake of fast-moving storms, upward isotherm displacement occurs at the center of the track from the MLD to about 150 m. At about two RMAX to the right of the storm, large subthermocline temperature increases are present to 100 m. A much smaller region of subthermocline temperature increases is evident to the left of the center. These temperature increases are associated with the MLD increases. The maximum MLT decreases are located between the regions of subthermocline temperature decreases along the track and the increases to the right of the track. The magnitude of these anomalies is a function of storm speed and initial thermocline depth, as well as subthermocline stratification. In large, slow-moving storms, SST decreases induced by a storm can cause a reduction in the sensible heat flux by up to a factor of four, and in latent heat flux by up to a factor of two. Inner core SST decreases of 2°C, or more, in 24 hours were correlated with filling rates of central pressure (PMIN) of 0.7 to 2.4 mb/hr for 6-24 hours in seven storms that were studied.

AO-005
BLACK, P. G. Tropical storm structure revealed by stereoscopic photographs from Skylab. Advances in Space Research 2:115-124 (1983).

A stereo pair of photographs taken by Skylab astronauts over Hurricane Ellen, September 19, 1973, resulted in the first stereo analysis over tropical storms. This pair is also the first evidence to indicate the existence of "supercell" convection in developing tropical storms. The photos are analyzed to determine the cloud top structure of the intense convection occurring in one quadrant of the storm. This type of supercell convection in tropical storms has recently been correlated with subsequent rapid deepening. The stereo analysis revealed that a circular cloud feature over the storm center was a dome which protruded 3-4 km above the undisturbed cirrus clouds. The center of the dome was capped by smaller scale convective turrets which protuded another 1-2 km above the dome. The existence of shear induced waves in the cloud tops is shown with wave amplitude ranging from 150-300 m and wave lengths ranging from 2-4 km. The existence of gravity waves at the cloud tops is also shown with wave amplitudes of 500-600 m and wavelengths of 10-12 km.

AO-006
BLACK, P. G., and W. L. ADAMS. Guidance for estimating surface winds based on sea state observations from aircraft and sea state catalog. FCM-G1, NOAA, Federal Coordinator for Meteorological Services and Supporting Research, Washington, D.C., 85 pp. (1983).

No abstract.

AO-007

BLACK, R. A., P. T. WILLIS, and J. Hallett. Case studies of ice distribution in hurricanes. Preprints, Conference on Cloud Physics, November 25-27, 1982, Chicago, Illinois. American Meteorological Society, Boston, Massachusetts, 335-337 (1982).

No abstract.

AO-008

CHEW, F. Curvature bias in the Florida Current off Miami. _Journal of Physical Oceanography_ 13(2):346-352 (1983).

The evidences for and the mechanism of a negative curvature bias in the Florida Current off Miami are presented. The evidences consist of a re-examination of the data tests by Schmitz (1969) and Stubbs (1971). Three different approaches are used in re-examining the first work, and all three clearly give a negative curvature bias. In revealing consistent evidence for a supergeostrophic flow, the second work supports the same bias. Thus, both works indicate a persistent tendency for fast, inertial flows to meander even when within a channel. Apparently triggered by and hence tied to the channel constriction off Miami, the curvature mechanism involves a divergence with magnitude an order larger than the geostrophic divergence, and correspondingly larger inertial torques in both the cross- and downstream directions.

AO-009

CLARKE, T. L. Simple flat-field eyepiece. _Applied Optics_, 22:1807-1811 (1983).

A simple three-element eyepiece is presented which has a zero Petzval sum and is corrected for both longitudinal and lateral color. Following a third-order analysis, results of ray tracing several examples are presented. Designs using a single glass are useful at f/4 and 40°, and multiglass designs can be used at f/3 and 40°. These latter designs also correct the coma of a paraboloidal mirror objective.

AO-010

CLARKE, T. L., W. L. STUBBLEFIELD, and D. J. P. Swift. Use of power spectra to estimate characteristics of sand ridges on continental shelves. _Journal of Geology_, 91:93-97 (1983).

Attempts to explain the origin of sand ridges on continental shelves require objective means for quantifying their wavelengths and orientations. Two-dimensional power spectral analysis is such an approach. However, mathematical peculiarities may lead to apparent discrepancies between the results of spectral analysis and wavelength estimates from bathymetric maps. This discrepancy may explain much of the reported difference between wavelength predictions based on hydrodynamic stability theory and measurements from bathymetric maps. Such a discrepancy can be significantly reduced by a modified spectral analysis technique which utilizes power spectra of bottom slopes rather than bathymetry.

AO-011

CLARKE, T. L., D. J. P. Swift, and R. A. Young. A numerical model of fine sediment transport on the continental shelf. _Environmental Geology_ 4:117-129 (1982).

A numerical model of fine-grained sediment dispersion in the New York Bight of the North American continental shelf is presented. Large amounts of waste material have been dumped in this region and the dispersal patterns of this material are of great interest to environmental managers. The model assumes that fine sediment resuspension is determined by surface wave activity and that transport is determined by tidal currents. Considering surface wave activity to be a random process reduces sediment motion to a random walk which is governed by a diffusion equation. The diffusion equation is solved numerically by an implicit time difference, finite element algorithm for a number of initial conditions. Initial conditions corresponding to ocean dumping sites show patterns of dispersal controlled by the geometry of the study region and the anisotropy of the tides. Material dumped at currently used dump sites reaches sensitive coastal areas before it leaves the continental shelf. Examination of the diffusion coefficients suggests an alternative dump site for fine-grained material. This dump site is relatively near sources of dumped material but produces minimal impact on coastal areas. This site should be considered as a possible alternative to expensive direct disposal at deep ocean sites.

AO-012

CLARKE, T. L., B. Lesht, R. A. Young, D. J. P. Swift, and G. L. FREELAND. Sediment resuspension by surface-wave action: An examination of possible mechanisms. Marine Geology, 49:43-59 (1982).

Detailed spectral and coherence analyses of both nephelometer data and near-bottom acoustic concentration profiles support the conclusion of Lesht et al. (1980) that surface-wave activity is the most important input to the sediment resuspension processes. The sand-sized fraction is suspended primarily by bursts of turbulence which are related to peak values of the envelope of surface waves. Two mechanisms for the resuspension of fine sediment are considered. When the bed is bimodal sand and silt, pore-water motion induced by wave-pressure fluctuations may carry fine particles into the boundary layer where they are suspended. Motion of the sand matrix as bedload will also expose fine particles to the flow so that they become suspended. The combination of these two mechanisms accounts for the observed quasi-linear relation between wave orbital velocity and suspended sediment concentration for the Long Island data. The second mechanism is also consistent with observations of near-bottom fluid velocity and suspended sediment concentration in Norton Sound, Alaska.

AO-013

CLARKE, T. L., R. A. Young, W. F. STUBBLEFIELD, D. J. P. Swift, T. A. NELSEN, and G. L. FREELAND. Summary results of Instep Project: New York Bight marine geology. NOAA-TM-OMPA-23 (1982).

Following a brief history of the INSTEP project, the data and scientific results produced by the project are summarized. In each of the three main study areas, seafloor inventory, suspended particulate measurements, and boundary layer measurements and modeling, the types of data taken and the methods used are briefly summarized. Sources from which copies of the data can be obtained are indicated. A complete bibliography of publications resulting from the INSTEP project is included.

AO-014

FRANKLIN, J. Omega dropwindsonde processing. NOAA-TM-ERL-AOML-54, 37 pp. (1983).

During the Global Atmospheric Research Program's Alpine Experiment (ALPEX) of 1982, 187 atmospheric soundings were obtained with Omega dropwindsondes. These data were post-processed at the NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML) Hurricane Research Division (HRD) to improve the quality of the data set. The errors common to Omega dropwindsonde data are described, and corrections of these problems through post-processing are illustrated using soundings from ALPEX and Hurricane Debby (1982). Advantages of post-processing are demonstrated by the improved accuracy of the data.

AO-015

FREELAND, G. L., R. A. Young, G. Drapeau, T. L. CLARKE, and B. L. BENGGIO. Sediment cap stability study, New York dredged material dumpsite, New York. District Corps of Engineers, Agreement No. NYD 80-124(C) (1983).

The project objective is to study the frequency and capability of sea-bottom currents to erode surficial sediment in a portion of the southeast quadrant of the New York dredged material dumpsite. The area under study had dredged material dumped which was determined, after the dumping occurred, to be unsuitable for unrestricted ocean disposal under the ocean dumping pollution criteria; this material was subsequently capped by clean dredged material. This study measured sea-bottom conditions on the surface of the cap from November 1980 to June 1981. It also attempts to reconstruct, through hindcasting and mathematical modelling techniques, what conditions might be expected at the site over a much longer period of time. Both actual and predictive analysis indicate a slight amount of erosion occurs during a 'normal' year. The bottom is particularly susceptable to erosion during the winter season when the water column is unstratified. Especially important for bottom sediment transport are storm conditions when the wind blows from directions of open water fetch: from east-northeast to south-southwest. Sea swell coming from these directions may also cause some transport. Severe conditions did not occur during the measurement period, nevertheless, some sediment transport, primarily to the south, did occur. Since the present surface of the cap contains high percentages of easily-transported fine sand, it is recommended that additional material be added to the cap, and that this material be clean sand as coarse as is economically available, but not finer than 0.25 mm in grain size.

AO-016

FRIEDMAN, H. A. Methods of analysis for forecasting in the tropics. In Guide on the Global Data Processing System. World Meteorological Organization Publication No. 305, 2nd edition, Geneva, Switzerland, V-1 - V-79 (1982).

No abstract.

AO-017

HALPERN, D., S. P. HAYES, A. LEETMAA, D. V. HANSEN, and S. G. H. PHILANDER. Oceanographic observations of the 1982 warming of the tropical eastern Pacific. Science 221(4616):1173-1174 (1983).

Moored current meter, sea level, hydrographic, and surface drifter measurements show the large changes that took place in the eastern tropical Pacific during the onset of the warm episode of 1982. In August the near-surface flow at 0°, 110°W reversed direction to eastward. By October the sea surface tempera-ture in the equatorial zone increased by 5° Celsius above the long-term monthly mean value, sea level rose by 22 centimeters at the Galapagos Islands, and the thermocline was displaced downward by 50 to 70 meters along the equator and the South American coast.

AO-018

HARVEY, G. R. Dissolved carbohydrates in the New York Bight and the variability of marine organic matter. Marine Chemistry 12:333-339 (1983).

Concentrations of dissolved carbohydrates in the New York Bight were determined hourly, daily and weekly in June and August 1978. Results of this and many other recently published studies reveal that the concentrations of dissolved organics change dramatically over short time scales. It is proposed that a total compound class analysis of any single seawater sample will account for most of the dissolved organic carbon in that sample.

AO-019

HARVEY, G. R., D. A. BORAN, L. A. Chesal, and J. M. TOKAR. The structure of marine fulvic and humic acids. Marine Chemistry 12:119-132 (1983).

Fulvic and humic acids were isolated from near surface seawater samples obtained at five biologically diverse sites in the Gulf of Mexico in quantities sufficient for detailed NMR and chemical studies. A gas lift pump and a 1500-l extraction facility provided half-gram quantities of material. The proton NMR spectra of all fulvic and humic acids studied were remarkably similar and differed mainly in the absence of aromaticity in the fulvics. These observations, coupled with published spectra and chemical data, suggest a class structure and general mechanism of formation for marine humic substances. The proposed structures are crosslinked, autoxidized, polyunsaturated fatty acids.

AO-020

HARVEY, G. R., N. S. Fischer, P. Bjerregaard, and L. Huynh-Ngoc. Interactions of marine plankton with transuranic elements. II. Influence of dissolved organic compounds on americium and plutonium accumulation in a diatom. Marine Chemistry 13:45-56 (1983).

To assess the significance of naturally occurring dissolved organic matter (DOM) on complexation of transuranic elements in seawater, a series of bioassay experiments was conducted in which the effect of DOM on the accumulation of ^{241}Am, ^{237}Pu (III-IV), and ^{237}Pu (V-VI) by the marine diatom Thalassio-sira pseudonana was measured. EDTA at 0.3 µM complexed both metals substantially, resulting in reduced radio-isotope uptake by the diatom; the greatest effect was on Pu (III-IV). In contrast, there was no apparent complexation of either element by equimolar concentrations of marine fulvic (MFA) or humic acids (MHA), naturally occurring photo-oxidizable DOM (uncharacterized), or diatom exudates, as none of these materials reduced isotope uptake; on the contrary, there were indications that some of this DOM enhanced transuaranic bioaccumulation in the diatom slightly. Subsequent experiments showed this enhancement was probably due to complexation of transition metals by the DOM, leading to fewer ambient ions "competing" for binding sites on the cells; ^{241}Am uptake rates were negatively correlated ($r = -0.846$, $P < .01$) with Σ ASV-labile Cu + Zn + Cd + Pb. These experiments suggest that naturally occurring DOM may not appreciably complex Am or Pu or greatly affect their bioavailability in the sea.

AO-021

HAWKINS, H. F. Hurricane Allen and island obstacles. Journal of the Atmospheric Sciences 40:1360-1361 (1983).

The first significant filling of Hurricane Allen coincided with its encroachment on Haiti, Jamaica and eastern Cuba. It is suggested that the filling was due to the interruption offered to its circulation by the mountainous terrain. The accompanying secondary wind maximum may have contributed to, or have been coincidental with, the weakening observed.

AO-022
Hawkins, J., and P. G. BLACK. SEASAT scatterometer detection of gale-force winds near tropical cyclones. _Journal of Geophysical Research_ 88(C3):1674-1682 (1983).

Hurricane Center advisories specifying the radius of gale force winds (GFW) in tropical cyclones are severely limited by inadequate data. Their accuracy is especially vulnerable in the data void tropical ocean regions. The SEASAT-A satellite scatterometer (SASS) sensed surface winds associated with numerous tropical cyclones. Although instrument design ruled out retrieval of winds within the inner core of the storm, surface truth studies indicate SASS can detect the threshold of gale force winds ($17-18 ms^{-1}$) with an accuracy comparable to the original SEASAT specifications ($\pm 2 ms^{-1}$ or 10% and $\pm 20°$). Accurate and abundant SASS observations were thus used as verification for advisories specifying the radius of gale force winds for tropical cyclones in the Pacific and Atlantic Ocean basins. Advisories were found to consistently overestimate the radius of GFW, often by a factor of two in the central Pacific. Large asymmetries in the GFW distribution measured by SASS were often in considerable disagreement with symmetric circular and semicircular advisory values. However, advisories that had access to low-level aircraft data closely matched SASS measured GFW values.

AO-023
JORGENSEN, D. P. Vertical-draft properties of mature hurricane cumulonimbus clouds. Preprints, Conference on Cloud Physics, November 15-17, 1982, Chicago, Illinois. American Meteorological Society, Boston, Massachusetts, 531-534 (1982).

No abstract.

AO-024
JORGENSEN, D. P., K. C. BELLE, and R. W. BURPEE. Airborne Doppler estimates of the air motions associated with a developing sea-breeze-induced mesoscale precipitation line. Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorology Society, Boston, Massachusetts, 670-674 (1983).

No abstract.

AO-025
JORGENSEN, D. P., P. H. Hildebrand, and C. L. Frush. Feasibility test of an airborne pulse-Doppler meteorological radar. _Journal of Climate and Applied Meteorology_ 22:744-757 (1983).

A vertically scanning, airborne, pulse-Doppler radar is described. Data processing methods to yield pseudo-dual-Doppler horizontal winds are presented. Results of an intercomparison with a ground-based dual-Doppler network are presented and discussed. These results indicate that the accuracy of the Doppler estimates are not seriously degraded by the aircraft's motion in a nonturbulent environment. Reasonable wind velocities were obtained in a stratiform precipitation (pre-warm-frontal) regime despite relatively long time periods for data gathering (~ 20 min). Potential error sources are discussed, with the principal conclusion being that the uncertainty in the airborne Doppler mean velocity estimates are slightly larger than would be expected for a ground-based Doppler. However, the time period over which data are gathered is much longer than for a ground-based dual-Doppler network. Potential modifications to the antenna and data system to improve data quality are also discussed.

AO-026
Lass, H. U., V. Bubnov, J. M. Huthnance, E. J. Katz, J. Meincke, A. de Mesquita, F. OSTAPOFF, and B. Voituries. Seasonal changes of the zonal pressure gradient in the equatorial Atlantic during the FGGE year. _Oceanologica Acta_ 6:3-11 (1983).

Dynamic height measurements relative to the 500 dbar surface in the Atlantic Ocean distributed between 2°N, 2°S, 44°W and 7°E and August 1978 to March 1980 have been analyzed. In general, the pressure gradient is variable along the equator evidently due to zonally varying winds. Extremely large values of the pressure gradient have been observed in the western part of the equatorial Atlantic boreal winter 1979 and 1980. The seasonal cycle of zonal pressure gradient at the 50 dbar surface has in the central equatorial Atlantic a minimum in March to April. The pressure gradient reaches its yearly maximum value in September to October. In the central Atlantic the mean value and the yearly cycle of the equatorial zonal pressure gradient is nearly balanced by the westward directed wind stress. There is evidence of a time delay of the order of one to two months between the zonal windstress and the zonal pressure gradient in the equatorial Atlantic.

AO-027

LAWSON, L. M., and R. B. LONG. Multimodal properties of the surface-wave field observed with pitch-role buoys during GATE. Journal of Physical Oceanography 13:474-486 (1983).

A sophisticated analysis technique is applied to a subset of pitch-roll buoy data collected by the research vessels GILLISS and QUANDRA during the GARP Tropical Atlantic Experiment (GATE) in September 1974. The procedure enables the examination of directional properties of the wave field at a level of detail not previously achievable. Attention is focused on a wave event caused by the passage of a cyclone across the North Atlantic along 44°N latitude. By comparing properties of the observed spectra with the predictions of a simple schematic model of the storm, we conclude that swell reaching the GATE area was emitted during the first half of the storm's lifetime; swell subsequently radiated from the storm was heavily attenuated, either by sheltering of the site by the Cape Verde Islands or because of radically lower emission levels from the storm itself. This work illustrates the power, as well as the limitations, of the pitch-roll buoy when used in conjunction with a fully effective analysis technique.

AO-028

LEETMAA, A. Observations of near-equatorial flows in the eastern Pacific. Journal of Marine Research 40 (Supplement):357-370 (1983).

Direct measurements were made in 1980 and 1981 of the near-equatorial flow field along sections at 110°, 102.5°, 95°, and 85°W. The Equatorial Undercurrent weakens as it approaches the Galapagos. Most of the transport is lost from the warmer, upper part of the current. In June 1981, the transport at 110°W was 26 Sv (1 Sv = 10^{12} gm/sec) and at 95°W it was 13 Sv. However, further to the east at 85°W only a trace of eastward flow was present above 150 m and most of the flow was westward. To the west of the Galapagos the bulf of the eastward flow lies asymmetrically south of the equator. In the surface layers eastward flows extends southward to 3°S. This appears to be distinct from the Undercurrent. It is argued that this shallow eastward flow is driven by the curl of the wind stress. At 110°W the net transport within 3° of the equator was close to zero. The eastward transport of the Undercurrent was compensated for by westward transport in the South Equatorial Current north of the equator.

AO-029

LEETMAA, A. The role of local heating in producing temperature variations in the offshore waters of the eastern tropical Pacific. Journal of Physical Oceanography 13(3):467-473 (1983).

The role of local heating in producing annual and interannual sea-surface temperature variations in the eastern tropical Pacific is studied. Removed from the eastern boundary (122°W), and off the equator, local heating plays a major role in producing annual temperature fluctuations. At the same longitudes from 10°N to 10°S interannual variations in the yearly-average temperature and the anomalous net heat input into the ocean are of the same sign and magnitude. During the 1969 and 1972 ocean warmings there was increased heat input into the ocean. Closer to the eastern boundary, oceanic processes such as advection are as important as local heating. Results from a simple model incorporating local heating, offshore Ekman transports, and upwelling suggest the following scenario for the 1972-73 El Nino. During February and March 1972 enhanced local heating and reduced offshore advection were the main reasons for anomalously warm temperatures in the open ocean adjacent to Peruvian coastal waters. From April 1972 to March 1973 temperatures remained high because of offshore transport of anomalously warm inshore waters. Whether the latter were warm because of upwelling of warmer water or transport of warmer water from farther south is not clear.

AO-030

LEETMAA, A., D. R. Quadfasel, and D. WILSON. Development of the flow field during the onset of the Somali Current, 1979. Journal of Physical Oceanography 12:1325-1342 (1983).

During the spring and summer of 1979 a multi-ship survey studied the changes in currents along the East African coast in response to the transition from the northeast to the southwest monsoon. The Somali Current in late April and early May flowed southwestward along the coast from northern Somalia to about the equator. Surface currents were 50-100 cm s^{-1} and the transport was 3×10^6 m^3 s^{-1}. South of the equator the East African Coast Current (EACC) flowed northward. The two currents met in the vicinity of the equator and turned offshore to the southeast. Surface velocities in the EACC were about 200 cm s^{-1}, and its transport in the top 10 m was 15×10^6 m^3 s^{-1}. With the initial onset of southerly winds in early May the Somali Current reversed. By mid-May at 3°N surface speeds of 200 cm s^{-1} were observed. The flow did not continue up the coast, but turned offshore by 4°N. The second onset of the monsoon took place in mid-June. Shortly after this, surface currents > 350 cm s^{-1} were observed at the turn-off region. The transport at 3°N was 27×10^6 m^3 s^{-1} in the top 100 m. Farther to the north, northeasterly flow was observed as early as March. With the monsoon onset in June a strong anticyclonic

circulation developed between 5 and 10°N. This continued to strengthen into July. The transport in the top 100 m in late June was 22×10^6 m^3 s^{-1}. Energetic, organized flows were observed below the surface layer. North of the equator between 100 and 450 m, the flow was already to the northeast in mid-April. This coastal flow was fed by westward flow along the equator at this level. Little change was seen in this portion of the water column with the monsoon onsets. Around 700 m along the coast the flow was to the southwest with a speed of 50 cm s^{-1} in late April to mid-May. Flow at 700 m along the equator was to the west. Close to the coast this turned to the southwest. With the reversal in the surface current, the deep southwestward flow also reversed north of the equator. This deep northeastward flow increases the net transport at 3°N to about 80×10^6 m^3 s^{-1}. A persistent, nearshore, southwestward undercurrent was seen in the northern gyre in May-July. The current changes in the surface layer were primarily related to changes in the local winds and a northward intrusion of the EACC into the Northern Hemisphere. No direct evidence for strong remote forcing was seen. It is not clear what causes the changes in deep water.

AO-031
LEWIS, B. M., AND H. F. HAWKINS. Polygonal eyewalls and rainbands in hurricanes. Bulletin of the American Meteorology Society 63:1294-1300 (1982).

It was noted from analyses of radar data obtained in hurricanes that both the spiral bands and the inner boundary of the wall cloud frequently were composed of a series of straight line segments. Indeed, the eye of a strong hurricane is frequently polygonal rather than circular or elliptical. These features may have a possible kinematic explanation based on interference among differing wavenumbers and frequencies of internal gravity waves.

AO-032
MARKS, F. D., JR. Three-dimensional reflectivity distribution in the eyewall of Hurricane Allen. Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society, Boston, Massachusetts, 305-310 (1983).

No abstract.

AO-033
MARKS, F. D., JR., and R. A. Houze, Jr. Three-dimensional wind field in the developing inner core of Hurricane Debby. Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society, Boston, Massachusetts, 298-304 (1983).

No abstract.

AO-034
MAUL, G. A. Review. Circulation and fronts in continental shelf seas: A Royal Society Discussion. J. F. Swallow, F. R. S., R. I. Currie, A. W. Gill, and J. H. Simpson, organizers. The Royal Society, 6 Carlton House Terrace, London, SW 1Y 5AG, England, 1981, 177 pp. (1983).

No abstract.

AO-035
MAYER, D. A. The structure of circulation. MESA physical oceanographic studies in New York Bight, 2. Journal of Geophysical Research 87(C12):9579-9588 (1983).

The structure of velocity in New York Bight (NYB) is examined for motions in the low frequency meteorological band (periods greater than three days) and for those in the semidiurnal band during the years 1975, 1976, and 1978. An empirical modal analysis suggests that, in the lower part of the water column in the unstratified season, nearly 80% of the low frequency energy is in phase across the shelf and is organized along the major isobaths. These motions exhibit a remarkable coherence that is visually apparent across the shelf for distances up to 80 km. Near-surface motions are less organized presumably because of the surface wind stress field. Maximum coherence between the observed wind stress and currents occurs with wind angles that vary from 60°T near the New Jersey coast to 80°T at mid-shelf just northeastward of the Hudson Shelf Valley which is consistent with the analysis of sea level records by Wang (1979). Wind-coherent motions represent about 50% of the low frequency energy in the northern section of NYB off Long Island and as much as 70% in the southern section off New Jersey. The analysis suggests the existence of a wind-coherent disturbance propagating southwestward on the outer shelf at about 540 km/day. This phase speed is consistent with earlier studies (Ou et al., 1981). In the higher

frequencies, the M_2 semidiurnal tidal current is in phase and rotates clockwise throughout NYB with the major axes organized approximately across the shelf.

AO-036
MAYER, D. A., G. C. Han, and D. V. HANSEN. Circulation in the Hudson Shelf Valley: MESA physical oceanographic studies in the New York Bight, 1. Journal of Geophysical Research 87(C12):9563-9578 (1983).

Over 900 days of current velocity data were obtained at mainly two locations in the inner and outer Hudson Shelf Valley (HSV). The large cross-axis depth gradients in the HSV, together with the strong winter cyclones and the baroclinic density distribution over the shelf, are primarily responsible for the major circulation features observed in the valley. CSTD data from 12 cruises and meteorological data from JFK International Airport and an environmental buoy were collected concurrently with the current meter data. Although the mean cross-shelf pressure gradient is generally seaward in the Middle Atlantic Bight, it is shoreward in the HSV below the level of the adjacent continental shelf (shelf horizon), thus imposing a bias toward upvalley flow. The average velocity below the surrounding shelf horizon in the HSV is upvalley or shoreward (west-northwestward ≈ 290°T) in the range of 2-5 cm/s. The circulation in the HSV is seasonal and individual events can drastically alter the mean picture. The several day average upvalley flow can sometimes approach 20 cm/s when intense winter cyclones pass over the bight and can sometimes also be directed downvalley depending upon the path of the winter cyclone. A topographically controlled barotropic flow commonly opposes the dominant (southeastward) wind direction even near the surface in the winter. In the context of circulation on the open shelf, upvalley (downvalley) flow events generated by winter cyclones are associated with reduced (enhanced) south-westward flow or flow reversals that are northeastward in the lower half of the water column at LTM, a typical mid-shelf site (Mayer et al., 1979). Current meter data suggest that whether or not reversals occur on the open shelf depends upon the interannual variability of the winter wind regime. Upvalley flow events are not confined only to the winter (unstratified) season but are stronger in the winter and can last for several days and longer. During the summer (stratified) season the maximum horizontal KE in the upper part of the water column shifts from the meteorological forcing band, characteristic of winter, to diurnal inertial and semidiurnal frequencies. In the diurnal band there appears to be a strong relationship between the diurnal wind and currents near the surface in the HSV as well as on the open shelf (LTM). The structure of the semidiurnal motions in the inner valley where the depth gradients are larger than in the outer valley has a significant depth dependence unlike most regions on the shelf, i.e., during all times of the year the semidiurnal tidal ellipse is anticlockwise in the lower 20 m of the water column.

AO-037
MCLEISH, W., and D. B. ROSS. Imaging radar observations of directional properties of ocean waves. Journal of Geophysical Research 88:4407-4419 (1983).

SEASAT-A synthetic aperture radar (SAR) and side-looking airborne radar (SLAR) images of ocean waves are examined in the form of normalized directional distributions of backscatter variance at series of frequencies. This method provides a more detailed description of radar results than have contoured two-dimensional wave number spectra and reduces some of the uncertainties in relating radar measurements to the waves. The range of aspects of the radar distribution that parallel those of ocean waves is defined. Within this restriction, not only can dominant wave frequencies and directions be determined accurately, but also the shape of a directional peak at a frequency, its directional width, and the background level can be determined approximately. Some of these aspects are examined with SLAR images obtained near reference wave measurements. Through its superior directional resolution, the radar appears to have distinguished two wave trains at a single frequency only 20° different in direction. The SEASAT-A satellite SAR provided an unusual opportunity to examine directional properties of waves in the hostile environment about Hurricane Fico. A swell highly dispersed in frequency and direction at a distance from the center of 450 km had a minimum observed directional width of 11°. Wave directions, their changes with frequency, and directional widths were in accord with those expected from the hurricane winds. Thematic maps of the direction and width of the swell energy as it spread across the ocean surface show smooth changes in these properties over distance, with relatively small scatter of individual values. These patterns also are in accord with those from a simple hurricane wave emission concept, but details of the distributions show distinct departures that must represent unrecognized smaller-scale fluctuations of the process.

AO-038
MOLINARI, R. L. Observations of eastward currents in the tropical south Atlantic Ocean: 1978-1980. Journal of Geophysical Research 87(C12):9707-9714 (1983).

Data from four cruises to the tropical South Atlantic Ocean are used to describe the current distribution at 25°W and 27.5°/28°W. Two distinct eastward-flowing countercurrents separated by a branch of the westward-flowing South Equatorial Current (SEC) were observed during all the cruises. The South Equatorial Undercurrent, located between 3°S and 5°S, has a subsurface velocity core, with maximum speeds of about 0.4 m/s. Geostrophic volume transport of the SEUC, from the surface to 1000 m, range from 5 to 23 Sv. Surface flow above the core of the SEUC can be to the east or west. The South Equatorial Countercurrent (SECC) is located typically between 7°S and 9°S. Although weaker than the SEUC with transports ranging from 3 to 7 Sv, the SECC also has a subsurface velocity core. Maximum speeds of 0.1 m/s are observed at about 275 m. Surface flow above the core of the SECC is typically to the east. Upper layer waters of the SECC are saltier and warmer than waters within similar density layers to the north.

AO-039
MOLINARI, R. L. Observations of near-surface currents and temperature in the central and western tropical Atlantic Ocean. Journal of Geophysical Research 88(C7):4433-4438 (1983).

Eleven satellite-tracked drifting buoys were deployed in the central South Atlantic Ocean during two austral summer and two austral winter cruises. Between 7°S and 11°S and 23°W and 31°W during austral winter, net buoy drift was to the west. Surface geostrophic flow was to the east between 7°S and 9°S. It is proposed that strong southeast trade winds can induce directly driven surface flows to the west that are more intense than the eastward geostrophic flows associated with the South Equatorial Countercurrent (SECC). A sustained period of eastward drift within the SECC was observed during austral summer, when the trades are weaker. The trajectories indicate surface waters north of 8°S have a mean northward meridional component and those south of 8°S a southward component. The buoys which drifted north became entrained into the North Brazilian Coastal Current (NBCC) and those that drifted south into the Brazil Current. One buoy left the NBCC at about 5°N to drift northeastward in the North Equatorial Countercurrent (NECC). This trajectory and historical ship drift reports suggest that the NECC may extend only to 35°W to 40°W during boreal winter. Temperature data obtained as the buoys drifted westward and northward suggest that increases in upper layer heat content can be attributed to heat fluxes through the sea surface.

AO-040
MOLINARI, R. L. Sea-surface temperature and dynamic height distributions in the central tropical south Atlantic Ocean. Oceanologica Acta 6(1):23-34 (1983).

Dynamic height and temperature observations collected during four cruises to the central tropical South Atlantic Ocean are presented. The dynamic topographies of the sea-surface along sections extending from 1°N to 9°S during two different austral summer and two different austral winter cruises are similar to topographies given earlier. They support the contention of Katz (1981) that the dynamic relief of the sea-surface in the Atlantic varies in phase with changes in the surface wind stress field. Synoptic and climatological sea-surface temperature (SST) distributions during early austral winter (June-July) are more symmetric with respect to the equator than SST distributions later in austral winter (August-September). Comparison of the observations with results from various numerical modelling efforts suggests that the early winter pattern may represent an ocean response to an increase in zonal winds, while the late winter pattern may include an additional response to an increase of meridional winds.

AO-041
MOLINARI, R. L. STACS: Subtropical Atlantic climate studies. EOS 64(1):2 (1983).

No abstract.

AO-042
MOLINARI, R. L., and D. A. MAYER. Current meter observations on the continental slope at two sites in the eastern Gulf of Mexico. Journal of Physical Oceanography 12:1480-1492 (1983).

Current-meter observations obtained at two sites on the continental slope of the eastern Gulf of Mexico, at nominal positions of 29°N, 88°W (the Mobile site) and 27.5°N, 85.5°W (the Tampa site) are presented. Data were collected at three levels at Mobile (90, 190 and 980 m) from July 1977 through August 1978 and at four levels at Tampa (150, 250, 550 and 950 m) from June 1978 through June 1979. At 90 and 190 m, the flow at Mobile was on the average to the east. Sustained periods of flow to the west were observed during the summer 1977 and spring 1978. During the periods of eastward flow, the wind was generally out of the north and during the periods of westward flow, the wind was out of the east. The

flow at the top meter at Tampa was on the average to the west, in the same direction as the average wind. At both sites, the motions are perturbed by events associated with the Loop Current. These events make it difficult to define any seasonal variability in the upper layers. The flow at the bottom meters is strongly aligned with the bottom topography and lacks a strong seasonal signal. Little barotropic tidal energy was observed at either site. At both sites, maximum diurnal energy occurred near the local inertial frequency at the upper levels. These motions are probably induced by either cold-front passages or other atmospheric events. At the bottom meters, maximum diurnal-band energy occurred near the K_1-tidal constituent. These motions are strongly time-dependent and they may be related to internal tides.

AO-043
MOLINARI, R. L., E. Katz, E. Fahrbach, and H. U. Lass. Near surface temperature observations obtained in the equatorial Atlantic Ocean during FGGE (1979). In Hydrodynamics of the Equatorial Ocean, J. C. J. Nihoul (ed.), Elsevier Science Publishers B. V., Amsterdam, printed in the Netherlands, 65-82 (1983).

Temperature and surface wind data collected across the equatorial Atlantic Ocean during the First GARP Global Experiment (FGGE), 1979, have been compiled to study the seasonal evolution of the near-surface temperature field. The development of the large-scale, sea-surface temperature (SST) field is characterized by the appearance during boreal summer of a tongue of cold water which extends from the eastern to western basin, on and south of the equator. During 1979, the cold water first appears at 4°W and 28°W during early May and at 22°W some four weeks later. East of about 20°W, the thermocline rises and the mixed layer becomes shallower simultaneously with the lowering of SST's. West of about 30°W, the thermocline and mixed layer deepen at this time. Below average temperatures are observed through October, as the thermocline redeepens in the east and continues to deepen in the west. The 1979 SST and thermocline distributions along the equator have been compared to climatological distributions derived from historical data. The FGGE year fields are qualitatively similar to the climatological fields. Surface wind data collected during FGGE indicate that the surface cooling occurs within several days of an increase in both components of wind at 4°W and 28°W and within several weeks of the wind increase at 22°W.

AO-044
Mollo-Christensen, E., F. OSTAPOFF, and S. WORTHEM. Heat transport due to inertial oscillations in a weakly diffusive ocean. Tropical Ocean-Atmosphere Newsletter 18:4-5 (1983).

No abstract.

AO-045
NELSEN, T. A. Time and method-dependent size distributions of fine-grained sediments. Sedimentology 30:249-259 (1983).

With increased interest in fine-grained sediments it is imperative that a firm basis exist for comparative studies of these cohesive sediments. In this study the size distributions of continental slope and rise muds are shown to be dependent on both method and duration of sample pretreatment. Statistical analysis of 171 size distributions indicates that of the four most frequently used sample preparation methods (soak, stir, shake and ultrasonify) the time required to reach a "terminal" distribution beyond which no "fine-shift" was detected varied from 15 minutes to > 90 hours for a given sample solely as a function of preparation method. Data from this study also indicate that sample preparation by simple soaking alone will probably yield fine-grained sediments which, when analyzed by pipette or microsedimentation accumulation balance, undergo a continuous change in size distribution during analysis and may never reach a "terminal" distribution during the analysis time. On the other hand, stirring and ultrasonification were shown to be the most rapid and consistent methods for obtaining a sample's "terminal" distribution.

AO-046
NELSEN, T. A., and R. H. Bennett. Seafloor characteristics and dynamics affecting geotechnical properties at shelfbreaks. Society of Economic Paleontologists and Mineralogists 33:333-355 (1983).

No abstract.

AO-047
  PALMER, D. R., and M. L. Blodgett. Numerical calculations using the parabolic-equation technique.
  NORDA Parabolic Equation Workshop, NORDA Technical Note 143 (1982).

  No abstract.

AO-048
  O'Brien, J. J., and S. B. GOLDENBERG. Atlas of tropical Pacific wind stress climatology, 1961-1970.
  Florida State University Press, Tallahassee, Florida, 150 pp. (1982).

  No abstract.

AO-049
  ORTNER, P. B., C. KREADER, and G. R. HARVEY. Interactive effects of metals and humus on marine
  phytoplankton carbon uptake. Nature 301:57-59 (1983).

  Although certain trace metals are essential micronutrients required for growth, elevated concen-
  trations of some of the same metals exert deleterious effects on marine phytoplankton populations.
  Laboratory studies have indicated that metal toxicity depends on metal ion concentrations rather than
  total dissolved metals. Although it is believed that bioavailability is largely controlled by the
  degree to which dissolved trace metals are organically chelated, it has not been definitively esta-
  blished which organic compounds chelate trace metals in natural seawater. In an effort to define
  ecologically significant interactions between dissolved trace metals and naturally occurring organic
  matter we selected marine humus (humic and fulvic acids) as being likely to interact with trace metals
  in seawater. These compounds, derived from plant and animal sources, are being widely studied for their
  role in the transport and toxicity of metal ions in terrestrial, aquatic, and marine ecosystems and are
  known to comprise up to half of the total dissolved organic matter in seawater. Guided by a recent
  hypothesis explainng the structure of marine humus and its geochemical diagenesis, a laboratory
  synthesis of marine fulvic acid was accomplished. The resulting material was physically, spectroscopi-
  cally and chemically identical to one or more natural marine fulvic acids isolated from the Gulf of
  Mexico. We confirm here that isolated natural marine fulvics and marine fulvics synthesized in the
  laboratory affect the bioavailability of trace metals to marine phytoplankton.

AO-050
  PARRISH, J. R., R. W. BURPEE, F. D. MARKS, JR., and R. Grebe. Rainfall patterns observed by digitized
  radar during the landfall of Hurricane Frederic (1979). Monthly Weather Review 110:1933-1944 (1982).

  In September 1979, two research teams traveled to the coastal area in the path of Hurricane Frederic
  to record observations of the storm's rainbands with mobile radar recorders. The researchers were in
  position at the National Weather Service offices at Slidell, Louisiana, and Pensacola, Florida, a few
  hours before Frederic's outer convective bands reached the Gulf Coast. Although the recorder taken to
  Pensacola was damaged in transit, the recording system at Slidell collected digital data for 26 h as
  Frederic moved ashore at 6-7 m s^{-1}, approximately 125 km to the east of Slidell. Calculations of storm-
  total rainfall indicate that local rainfall maxima tended to occur in two general areas: (1) parallel
  to the coast near the point of landfall, with a northward extension approximately along Frederic's
  track, and (2) on a long band oriented from south-southeast to north-northwest ~ 50 km to the west of
  the storm track. The storm-total rainfall maximum along the coast was explained by a rapid increase in
  the intensity and area coverage of deep convection in mesoscale rainbands in the north eyewall that
  occurred as the north eyewall interacted with the coastline. Raingage-radar comparisons indicate that
  the storm-total rainfall estimated by the radars is probably within a factor of 2 of the true value.
  Maximum rainfall totals measured by gages and determined by radar were ~ 250 mm. Frederic's maximum
  accumulated rainfall was slightly below average, relative to other hurricanes that have made landfall
  along the Gulf Coast of the United States. During the four hours that the most intense convection in
  the north eyewall was near the coast, maximum hourly rainfall rates were 50-75 mm. In this four-hour
  period, 3% of the land area within 100 km of the center had hourly rainfall > 50 mm h^{-1}, and 39% of the
  same area had rain rates of 25-50 mm h^{-1}. Land areas with the greatest wind damage were highly corre-
  lated with the location or radar-observed reflectivities $\geq$ 41 db(Z). Analyses of time series of radar
  reflectivities and 5 min peak wind gusts at the surface indicate that the maximum surface winds near the
  coast occurred a few kilometers inside the radar eye.

AO-051

PIOTROWICZ, S. R., G. R. HARVEY, M. S. YOUNG, R. A. Courant, and D. A. BORAN. Studies of cadmium, copper and zinc interactions with marine fulvic and humic materials in seawater using anodic stripping voltammetry. In Trace Metals in Sea Water, C. S. Wong, E. Boyle, J. D. Burton, K. W. Bruland, and S. D. Goldberg (eds.), Plenum Publishing Co., New York, 699-717 (1983).

Humic and fulvic acids isolated from seawater were found to interact with Cd, Cu, and Zn in different ways at natural levels of these elements and natural pH in seawater. Fulvic acids exhibit strong inter-action with Zn while Cd and Cu have little or no interaction on the time scale of the diurnal cycles of plankton or bacteria. The Zn-fulvic acid interactions in surface waters probably occur as part of a steady-state cycle of less than 40 hours duration controlled by photo-oxidation and bacterial processes. The interaction of Cd, Cu and Zn with humic acids is much more complex. It appears that the natural association of metals and dissolved humic and fulvic acids is so dynamic that once a seawater sample is taken into a closed container for analysis, natural productive and destructive equilibria slow and finally cease. Thus, our perception of how metal-organic interactions occur in the ocean depends upon how quickly samples can be analyzed because true oceanic conditions cannot be duplicated. The use of synthetic complexers to study trace metal chemistry in seawater is discouraged.

AO-052

POWELL, M. D. The transition of the Hurricane Frederic boundary-layer wind field from the open Gulf of Mexico to landfall. Monthly Weather Review 110:1912-1932 (1982).

Numerous aircraft, ship, buoy and land station data were composited with respect to the center of Hurricane Frederic for two time periods: a 24 h period corresponding to the storm's position in the open Gulf of Mexico on 12 September 1979, and an 8 h period corresponding to the landfall of Frederic near 0400 GMT on 13 September. Comparison of wind analyses for the two periods indicated a rotation of maximum inflow angles from the southeast to northeast quadrants and a strong frictional decrease of wind speed over land. These and other features of the landfall analysis were compared with a model landfall study by Moss and Jones (1978). The landfall composite wind field was compared with the Fujita damage vector analysis to determine the damage time interval and mean wind speed range. Damage vector direc-tions were found to be well correlated with the surface streamlines, with the most severe damage being associated with Frederic's northern eyewall. Ten-meter-level wind speed data over water (V_o) and at coastal stations (V_L) were used to formulate approximate relationships of the low-level (500-1500 m) aircraft wind (V_a) to the mean coastal wind and peak gust (V_{LG}) in the same position relative to the storm center. It was found that $V_o = 0.7 V_a$, $V_L = 0.8 V_o$, $V_{LG} = 0.8 V_a$ and $V_L = 0.56 V_a$. These relationships should aid forecasters in their assessments of low-level aircraft reconnaissance wind data for use in issuing warnings. The vertical shear of the horizontal wind determined from radiosonde data for two inland stations was compared with shear determined from surface and aircraft data over water. The overland shear was greater than the overwater shear, by a factor of 2, in the same relative part of the storm. The "thermal wind" shear computed in the vicinity of the center was negligible, although the 10 m level air temperature analysis over land indicated a cold core that was probably caused by adia-batic cooling.

AO-053

ROFFER, C., and A. LEETMAA. CTD/O_2 data collected in November 1981 and March 1982 for EPOCS. NOAA-TM-ERL-AOML-52 (1983).

Hydrographic data collected on two cruises during the Equatorial Pacific Ocean Climate Studies (EPOCS) in 1981 and 1982 are reported. The data were recorded with a Neil Brown Instrument Systems (NBIS) CTD/O_2. Descriptions of the CTD/O_2 instrument, and data acquisition, processing and calibration tech-niques are given. Profiles of temperature, salinity, sigma-T and oxygen are plotted for each cast. The cruise track for both cruises is shown.

AO-054

RONA, P. A. Evaporites at passive margins. In Dynamics of Passive Margins, R. A. Scrutton (ed.), American Geophysical Union, Geodynamics Series, Washington, D.C., 6(200):116-132 (1982).

No abstract.

AO-055

RONA, P. A. Exploration for hydrothermal mineral deposits at seafloor spreading centers. Marine Mining 4:7-38 (1983).

No abstract.

AO-056
RONA, P. A. Hydrothermal processes at seafloor spreading centers: Report on a NATO Advanced Research Institute. EOS, Transactions of the American Geophysical Union 63:770-771 (1982).

No abstract.

AO-057
RONA, P. A. Hydrothermal processes considered. Geotimes 27(12):22-23 (1982).

No abstract.

AO-058
RONA, P. A. Polymetallic sulfides at seafloor spreading centers: A global overview. Marine Technology Society Journal 16(3):81-86 (1982).

No abstract.

AO-059
RONA, P. A. Review, "Geology of the northwest African continental margin," edited by U. von Rad, K. Hinz, M. Sarnthein, and E. Seibold, Episodes, IUGS 1983(1):46-47 (1983).

No abstract.

AO-060
RONA, P. A. Review, "Minerals from the marine environment," by P. Kent. American Scientist 70:416 (1982).

No abstract.

AO-061
RONA, P. A. Review, "Minerals from the marine environment," by P. Kent. Marine Mining, 3 (1982).

No abstract.

AO-062
RONA, P. A. Review, "The oceanic lithosphere," by C. Emiliani. American Association of Petroleum Geologists Bulletin 66:2698 (1982).

No abstract.

AO-063
RONA, P. A. Review, "Underwater minerals," by D. R. Cronan. Journal of Sedimentary Petrology 52:1029 (1982).

No abstract.

AO-064
RONA, P. A., K. Bostrom, and D. J. Stanley. Iron-cemented sediment on lower continental slope off Cape Hatteras. Geo-Marine Letters 2:89-94 (1982).

The textural, mineralogical, compositional and paleontological characteristics of an iron-cemented allochthonous sediment slab recovered from a zone of slumping between water depths of 2,100 and 2,350 m on the lower continental slope off Cape Hatteras are summarized. Results support interpretation of the sediment slab as the oxidized equivalent of pyrite-cemented Pleistocene to Recent sediment, an uncommon form of lithification in deep sea sediments. We propose that exposure of such slumped sediment slabs to seawater has produced an alteration sequence from pyrite-cement to iron oxide-cement. These observations extend the range of pyrite-cemented sediment initially reported from the water depths between 4,770 and 4,950 m on the lower continental rise off Cape Hatteras.

AO-065

Shearme, S., D. S. Cronan, and P. A. RONA. Geochemistry of sediments from the TAG Hydrothermal Field, M.A.R. at latitude 26°N. Marine Geology 51:269-291 (1983).

Sediments from the TAG Hydrothermal Field show evidence of hydrothermal inputs in the form of Fe, Cu, Zn and Mn enrichments. The Fe, Cu and Zn are thought to have been introduced as finely divided sulphides precipitated from suspension after dispersion away from now inactive hydrothermal vents and have since been oxidized. By contrast, the manganese is believed to be in the form of primary oxide precipitate. The processes of metal enrichment have been variably active during discrete intervals in the past. Geochemical partition analysis has demonstrated that the elements determined can be distributed differently between various phases in the different types of sediments studied, and that diagenetic transfer of elements from one phase to another occurs on burial. The general lack of metal enrichments in the sediments of the intensity sometimes found on the East Pacific Rise is thought to be largely the result of major metal pecipitation subsurface.

AO-066

Sunda, W. G., S. A. Huntsman, and G. R. HARVEY. Photoreduction of manganese oxides in seawater and its geochemical and biological implications. Nature 301:234-236 (1983).

Manganese is an essential micronutrient for all organisms. Its requirement by plants is particularly high because of its role in the oxidation of water in photosynthesis. According to the thermodynamic considerations, manganese should exist in oxic waters as MnO_2 which is insoluble and, therefore, not directly available for plant nutrition. In contrast to thermodynamic predictions, however, most of the manganese in near surface seawater exists as soluble reduced Mn(II). Although slow oxidation kinetics are at least partially responsible for the presence of Mn(II) in oxic waters, reduced manganese, nevertheless, should be converted to particulate manganese oxides (at rates that depend on several kinetic factors) and be lost from the water column by sinking. We report here experiments that demonstrate photoreduction of manganese oxides by dissolved organic substances (humic substances) in seawater. Such reactions appear to be important in maintaining manganese in a dissolved reduced form in photic waters, thereby enhancing its supply to phytoplankton.

AO-067

Swallow, J. C., R. L. MOLINARI, J. G. Bruce, O. B. Brown, and R. H. Evans. Development of near-surface flow pattern and water mass distribution in the Somali Basin, in response to the southwest monsoon of 1979. Journal of Physical Oceanography 13(8): (1983).

No abstract.

AO-068

Thompson, J. D., G. H. Born, and G. A. MAUL. Collinear-track altimetry in the Gulf of Mexico from SEASAT: Measurements, models, and surface truth. Journal of Geophysical Research 88(C3):1625-1636 (1983).

From September 17 to October 10, 1978, SEASAT made collinear passes over the Gulf of Mexico. Altimeter data for eight three-day repeat passes over the eastern Gulf were examined by using an arc segment fitting technique to determine the mesoscale temporal variability of the sea surface. The pattern of sea height variability was then compared with sea height data generated by a numerical model of the Gulf (Hurlburt and Thompson, 1980) from the simulation of a complex cycle of Loop Current intrusion and shedding of an anticyclonic eddy. The model data was found to match that from the SEASAT altimeter when an anticyclonic eddy separated from the Loop Current and the Loop began to repenetrate in to the eastern Gulf. Analysis of sparse ground truth data from ship of opportunity XBT's, satellite infrared imagery of the Loop Current boundary, and synthetic aperture radar (SAR) imagery, also from SEASAT, tend to confirm the circulation patterns deduced from the altimeter data and the numerical model.

AO-069

Vukovich, F. M., and G. A. MAUL. An observation of the surface circulation in a Gulf Stream frontal perturbation. Geophysical Research Letters 10(7):591-594 (1983).

In the period of 3-16 June 1979, a satellite-tracked, free-drifting buoy passed through a Gulf Stream frontal perturbation and was entrained into a warm filament on the shoreward side of the perturbation. Significant speed convergence was noted as the buoy passed through the perturbation and approached the counterclockwise turn into the warm filament. In the warm filament, the buoy drifted to the southwest at speeds of about 0.1 to 0.3 m/sec. Eventually, the buoy drifted out of the filament and went westward in an apparent response to wind-induced surface drift.

AO-070
WALTER, D. J., and J. R. PRONI. Acoustic remote sensing in the marine environment. In Manual of Remote Sensing, second edition, American Society of Photogrammetry 2:1403-1412 (1983).

No abstract.

AO-071
WILLIS, P. T., J. Hallet, and J. Jordan. The development of precipitation near the top of a maritime convective cloud. Preprints, Conference on Cloud Physics, November 25-27, 1982, Chicago, Illinois. American Meteorological Society, Boston, Massachusetts, 211-214 (1982).

No abstract.

AO-072
WILLOUGHBY, H. E., H. L. Jin, S. LORD, and J. PIOTROWICZ. A nonhydrostatic, axisymmetric model of hurricane dynamics with explicit convection and ice microphysics. Preprints, 6th Conference on Numerical Weather Prediction, June 6-9, 1983, Omaha, Nebraska. American Meteorological Society, Boston, Massachusetts, 275-281 (1983).

No abstract.

AO-073
WORTHEM, S., F. OSTAPOFF, and E. Mollo-Christensen. Formation of layers by instability and wave-induced fluxes in the equatorial ocean. Preprints, 4th Conference on Atmospheric and Oceanic Waves and Stability, March 22-25, 1983, Boston, Massachusetts, American Meteorological Society, 43 (1983).

Data obtained with a dual sensor probe and other instruments in the equatorial Pacific show layer structures, thermostads, velocity jets and various fine scale features. The processes contributing to the formation and maintenance of these features are discussed in the light of recent analysis of thermo-haline stability, wave induced flux processes and likely turbulent structure of the equatorial current system. The approximately hourly profiles show evidence of a semidiurnal internal tidal signal with a node in the Equatorial Undercurrent core. The structure of the layering appears to be related to the tidal cycle.

AO-074
WORTHEM, S., E. Mollo-Christensen, and F. OSTAPOFF. Effects of rotation and shear on doubly diffusive instability. Journal of Fluid Mechanics 133:297-319 (1983).

A linear stability analysis of a doubly diffusive system, with rotation and shear, shows that over-stable oscillations can occur in stratifications typical of the equatorial ocean, that internal waves encountering an equatorial current can exchange energy with the current, and that the wave-induced fluxes of salt and heat can lead to larger formation in the salinity, temperature and velocity fields.

CR-001
  DIAZ, H. F. Some aspects of major dry and wet periods in the contiguous United States, 1895-1981.
  Journal of Climate and Applied Meteorology 22(1):3-16 (1983).

  Using state monthly values of the Palmer Drought Index from January 1895 through April 1981, the spatial
and temporal features of dry and wet episodes over the contiguous United States were analyzed. The vari-
ance spectrum of the area under both drought and wet spells in the western United States (17 westernmost
states) was also investigated. The main results are as follows. Consistent with the findings of previous
investigators, the interior and western portions of the United States are found to be more drought-prone
than other parts of the country. By contrast, the likelihood of drought occurrence in states near
coastal areas is considerably less. Prolonged moisture abnormalities also tend to occur over the more
drought-prone states indicating a tendency toward bimodality (either "too dry" or "too wet"). The vari-
ance spectrum of the area under drought in the western United States exhibits a red-type spectrum, whereas
the wet spell area exhibits relatively greater variance at the highest and intermediate frequencies (2 and
3-9 years). In a few regions of the United States, the initiation and termination of drought episodes
tend to occur more often at certain times of the year. For most regions, however, this preference is only
marginal or non-existent.

CR-002
  DIAZ, H. F., R. G. Barry, and G. Kiladis. Climatic characteristics of Pike's Peak, Colorado (1874-1888)
  and comparisons with other Colorado stations. Mountain Research and Development 2(4):359-371.

  An analysis is made of the historical climatic data from Pike's Peak, Colorado. Characteristics of the
seasonal regime are described and these are compared with modern data for other mountain stations in the
area. Temperature and wind conditions are broadly similar at these stations, whereas the precipitation
regime at Pike's Peak more closely resembles that at Denver located on the High Plains, just to the east
of the Rockies and some 100 km to the north, than the other summit stations close to the Continental
Divide.

CR-003
  DIAZ, H. F., and J. Namias. Associations between anomalies of temperature and precipitation in the
  United States and western Northern Hemisphere 700 mb height profiles. Journal of Climate and Applied
  Meteorology 22(3):352-363.

  The relationship between anomalous seasonal surface temperature and precipitation in the contiguous
United States and concomitant fluctuations of western Northern Hemisphere 700 mb height as a function of
latitude are examined. Findings are consistent with other studies dealing with the spatial patterns of
midtropospheric teleconnections and their surface manifestations. A strong inverse relationship between
temperature in the eastern United States and heights in the western Northern Hemisphere polar regions is
present during winter and spring, especially in winter. In summer the association is positive and is most
evident in the southern tier of states. Fewer significant correlations are found between seasonal precip-
itation and midtropospheric height, with the strongest ones occurring in winter and summer. It is shown
that in winter, during the period 1948-81, the frequency of below-average 700 mb heights has increased in
the temperate latitudes of the western Northern Hemisphere. At the same time, a general increase in above
normal polar latitude heights has taken place. This in turn has been associated with lower winter tem-
peratures in the eastern United States.

CR-004
  FLETCHER, J. O. The difference between Southern Oscillation and El Nino. Proceedings, Seventh Annual
  Climate Diagnostic Workshop, Boulder, Colorado, October 1982. U.S. DOC, 231-240 (1983).

  No abstract.

CR-005
  Fu, Congbin, and J. O. FLETCHER. Large signals of climatic variation in Asian monsoon regions --
  northern summer. Proceedings, Seventh Annual Climate Diagnostic Workshop, Boulder, Colorado, October
  1982. U.S. DOC, 223-230 (1983).

  No abstract.

CR-006
  Fu, Congbin, J. FLETCHER, and R. Slutz. The structure of the Asian monsoon surface wind field over the ocean. _Climate and Applied Meteorology_ 22(7):1242-1252 (1983).

  This paper examines the structure of the summer monsoon over the Indian and western Pacific Oceans by analyzing the surface wind data from marine data sets for the period of 1860 to 1970. It is found that the southern edge of the huge monsoon low has three low-pressure troughs over the eastern edges of Africa, India, and the Indo-China peninsula. To the east of each trough is a broad region of intensified wind flow, with three branches in the western Arabian Sea, the Bay of Bengal, and the South China Sea, respectively. We call this the "branching phenomenon of the SW-monsoon." Each of these branches has its own characteristics, and these influence the rainfall pattern in South Asia. This is verified by the observed distribution of precipitation, which has maximum precipitation over the west coast of each peninsula. The cross-equatorial flow also shows the branching phenomenon, with three maxima at the same longitudes as the three branches of the SW-monsoon. A discussion of the relationships between the branching phenomenon and sea-land distribution suggests that the structure of this SW-monsoon wave is very different from that of waves in the westerlies in middle latitudes. The three monsoon troughs correspond to perturbations of the temperature field in the lower troposphere, reflecting the sea-land thermal contrast in this area, and correspond to the longitudes of strong cross-equatorial flows enhancing the monsoonal character of the surface wind field.

CR-007
  GARCIA, O., R. Grossman, M. Anderson, and Fan Huijun. A preliminary investigation of the relationship between tropical convection and subtropical jetstream variability over the southwestern Pacific Ocean. Proceedings, Seventh Annual Climate Diagnostic Workshop, Boulder, Colorado, October 1982. U.S. DOC, 247-251 (1983).

  No abstract.

CR-008
  GREENHUT, G. K. Stability dependence of fluxes and bulk transfer coefficients in a tropical boundary layer. _Boundary-Layer Meteorology_ 24:253-264 (1982).

  Turbulence data obtained aboard a NOAA P-3 research aircraft during flights over the eastern equatorial Pacific Ocean are used to obtain mean vertical profiles of water vapor density, potential temperature, wind speed and fluxes of latent heat, buoyancy and momentum. The variation of eddy fluxes and bulk transfer coefficients as a function of atmospheric stability are plotted for two of the flights. The observed transfer coefficients generally agree with those obtained from parameterizations based on surface-layer similarity theory (Deardorff, 1968; Kondo, 1975).

CR-009
  GREENHUT, G. K., and R. R. Brook. Similarity functions in the tropical marine boundary layer. _Boundary-Layer Meteorology_ 26:289-303 (1983).

  Mean profiles of virtual potential temperature, specific humidity, and the wind velocity components are obtained from aircraft data taken during the NORPAX trans-equatorial shuttle over the Pacific Ocean. The resulting parameters are used to calculate the similarity functions A, B, C, and D. These agree well with similarity functions obtained for the tropical Atlantic Ocean using GATE data (Fitzjarrald and Garstang, 1981). The similarity function A for wind speed over the tropical oceans is in good agreement with values obtained over land at higher latitudes. The tropical temperature and humidity functions, C and D, are lower than those obtained at higher latitudes, becoming negative as $h/(-L) \rightarrow 0$.

CR-010
  Grossman, R. L., and O. GARCIA. A seven year mean distribution of monsoon convective cloud and its variability. Proceedings, Seventh Annual Climate Diagnostic Workshop, Boulder, Colorado, October 1982. U.S. DOC, 172-179 (1983).

  No abstract.

WR-001

CARACENA, F., R. A. MADDOX, J. F. W. Purdom, J. F. Weaver, and R. N. Green. Multiscale analysis of meteorological conditions affecting Pan American World Airways flight 759. NOAA-TM-ERL-ESG-2, 45 pp. (1983).

No abstract.

WR-002

CUNNING, J. B., and M. DeMaria. An investigation of the interactions between developing convective systems and the boundary layer. Preprints, Conference on Cloud Physics, November 15-17, Chicago, Illinois. American Meteorological Society, 24-28 (1982).

No abstract.

WR-003

DOSWELL, C. A. III. The operational meteorology of convective weather. Volume I: operational meso-analysis. NOAA-TM-NWS-NSSFC-5, November (1982).

No abstract.

WR-004

DOSWELL, C. A. III, and R. A. MADDOX. Response to Comments on "Forecaster Training--A review and analysis." Bulletin of American Meteorological Society, Volume 64, Number 5, p. 518 (1983).

No abstract.

WR-005

FRITSCH, J. M., and J. M. BROWN. On the generation of convectively driven mesohighs aloft. Monthly Weather Review 110:1554-1563 (1982).

In an attempt to determine the relative contribution of the direct incorporation of cold air (detrainment from overshooting convective cloud tops) to the production mesohighs in the vicinity of the tropopause, two numerical simulations were performed using a 20 km horizontal resolution, 20-level primitive equation model. One simulation included direct cooling and the other did not. The results showed that including the cooling increased the high-level pressure and wind perturbations by approxi mately 30 and 40%, respectively. The simulation results also showed that in spite of the omission of the direct cloud cooling, a high-level cold pool was still generated. The cooling was accomplished by adiabatic expansion in response to the lifting by the convectively driven mesoscale vertical circulation. Thus, it appears that the mesoscale adiabatic expansion is the domi nant effect in elevated-mesohigh production and the detrainment of overshooting air is an important modifying factor.

WR-006

Grice, G. K., and R. A. MADDOX. Synoptic aspects of heavy rain events in south Texas associated with the westerlies. NOAA-TM-NWS-SR-106, 21 pp. (1982).

Meteorological conditions associated with 33 heavy rain events in south Texas have been examined. The results were compared with a study of voer 150 events by Maddox et al. (1979). Analyses of surface and standard level upper-air data revealed 31 of the 33 heavy rain events to be associated with either the frontal or mesohigh type patterns. Some geographical stratification appears to exist since the mesohigh events occur most frequently over south central and southeast Texas. Although the middle and upper troposphere create a favorable environment, instability and low-level moisture convergence appear to be necessary precursors for heavy rain. The area of maximum rainfall was found to be located near the intersection of the 850 mb maximum winds and the surface front or thunderstorm outflow boundary. The angle of intersection of these features is an important factor in the formation of heavy rains. Typical synoptic and mesoscale patterns are developed for the two heavy rain types and temporal distributions presented.

WR-007

GRIFFITH, C. G., and J. A. AUGUSTINE. An assessment of satellite rain estimates for large-scale, operational use. NOAA-TM-ERL-OWRM-17, 84 pp. (1982).

The feasibility of using a satellite rain estimation technique to operationally estimate convective rainfall over large areas and for long time scales is investigated. The area is the central third of the United States from the Rocky Mountains to the Mississippi River and from South Dakota to central Texas. A month of rainfall (August 1979) was estimated from GOES infrared data. Comparisons with gage data for the month and for three individual days are made. The sensitivity of the technique to the frequency of the satellite data is discussed. One case of satellite rain estimation for a wintertime storm is also shown.

WR-008

GRIFFITH, C. G., and J. A. AUGUSTINE. Wintertime and summertime satellite rainfall assessments for agricultural purposes. NOAA/NESS AgRISTARS Project Office, Washington, D.C., 40 pp. (1983).

Rainfall estimates were made for selected summertime and wintertime cases during 1979. The satellite rain estimation scheme that was used is the NOAA/ERL technique. This scheme was derived in south Florida for semi-tropical convection. Modifications to the scheme for its use in mid-latitude locations during the summer are described. Use of this technique for wintertime cases is discussed. Recommendations for further testing and for use in an operational setting are made.

WR-009

HOLLE, R. L., R. E. LOPEZ, and W. L. HISCOX. Relationships between lightning occurrences and radar echo characteristics in south Florida. Proceedings, International Aerospace and Ground Conference on Lightning and Static Electricity, June 21-23, 1983, Fort Worth, Texas. Federal Aviation Administration, New Jersey, 14-1 to 14-9 (1983).

Locations of cloud-ground lightning flashes were recorded during 1978 in south Florida: concurrently, radar data were digitized over a wide variety of meteorological conditions. Analyses show that a sharp difference exists between the frequency distributions of 1) radar cells (reflectivity maxima) associated with lightning flashes, which peaked at 46 dBz, and 2) cells without lightning, which peaked at 18 dBz. Similar results also apply for an area several kilometers around a flash, and indicate that only 20% of the radar data (above 30 dBz) accounted for nearly 70% of the collocated lightning. Other results specifying time relations, cell areas, and number of flashes are also described.

WR-010

HOLLE, R. L., and A. I. WATSON. Duration of Convective events related to visible cloud, convergence, radar and rain gage parameters in south Florida. Monthly Weather Review 111:1046-1051 (1983).

The time interval between initiation of surface convergence and the subsequent response of visible cloud growth to this convergence was examined for nine cases of convection that occurred over the FACE 1973 and 1975 mesonetworks in south Florida. Clouds ranged in size from small echoes with a few towers to merged lines or large clusters of towers, but they met a series of observational criteria that specified them as belonging to a similar set of clouds, and were not representative of the entire range of clouds in the area. Visible clouds first formed 10 to 55 min after the associated surface convergence began, and grew better by taking into account the duration of the cloud which is defined as the time from first surface convergence to complete dissipation. The same nine cases were examined as were chosen initially for the visible cloud study. When duration was considered, first visible cloud response occurred at an average of 15% through the cloud duration, and rapid upward cloud growth at 36%. Other parameters derived from divergence, radar- and gage-measured rainfall also tended to cluster within specific portions of the total duration of the cloud. The data for each event for the nine clouds are presented and described in terms of the cloud duration.

WR-011

Kuhn, P. M., R. L. Kurkowski, and F. CARACENA. Airborne operation of an Infrared Low-Level Windshear Prediction System. Journal of Aircraft, 20:170-173 (1983).

No abstract.

WR-012
  LOPEZ, R. E., R. L. HOLLE, and W. L. HISCOX. Climatological Characteristics of lightning over south
  Florida and their correlation with radar activity. Proceedings, International Aerospace and Ground
  Conference on Lightning and Static Electricity, June 21-23, 1983, Fort Worth, Texas. Federal Aviation
  Administration, New Jersey, 15-1 to 15-16 (1983).

  The analysis of lightning, radar, and sounding data for two summer months in south Florida has shown
  that there is a relationship between the degree of cloud-to-ground flash activity during the day and cer-
  tain combination of meteorological parameters detected early in the morning before significant convection
  develops. In general, it appears that clouds tend to be better flash producers (per unit area) under con-
  ditions of suppression of convection and light winds. As the atmosphere becomes disturbed, the clouds
  (although greater in numbers) tend to be less intense in their lightning activity.

WR-013
  LOPEZ, R. E., R. F. REINKING, J. Hallett, and J. JORDAN. 5-cm radar echoes and their microphysical
  significance in Florida cumuli. Preprints, Conference on Cloud Physics, November 15-18, 1982, Chicago,
  Illinois. American Meteorological Society, Boston, 183-186 (1982).

  No abstract.

WR-014
  LOPEZ, R. E., J. THOMAS, D. O. BLANCHARD, and R. L. HOLLE. Estimation of rainfall over an extended
  region using only measurements of the area covered by radar echoes. Preprints, 21st Conference on Radar
  Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada. American Meteorological Society,
  Boston, 681-686 (1983).

  One of the most relevant problems in meteorology today is to estimate the amount of rainfall that has
  fallen over a given region during periods of 6-12 hours. Such estimates are usually needed in near real
  time. It would be desirable to have an accurate technique for remotely measuring such rain volume that is
  simple, practical, and inexpensive. During the analysis of the vast volume of hydrological and meteoro-
  logical data collected during the Florida Area Cumulus Experiment, it was noticed that the single most
  important characteristic of convective cloud systems that determines their precipitation yield, is their
  horizontal area. That led to the idea that if the area covered by showers over a region could be measured
  with a radar at appropriate intervals during a period of time, the volume of rain falling during that
  period could be conveniently estimated with high accuracy. Using data from more than 150 days it is shown
  that the daily sums of hourly-measured echo areas are very well correlated to the corresponding rain vol-
  umes. The rain volumes were estimated using both 5 minute radar scans and a network of 130 to 150 rain-
  gages. In some cases correlation coefficients of 0.92 were obtained.

WR-015
  MADDOX, R. A. Large-scale meteorological conditions associated with midlatitude, mesoscale convective
  complexes. Monthly Weather Review, 111:7:1475-1493 (1983).

  Objective analyses of composited meteorological conditions attending ten Mesoscale Convective Complexes
  (MCC) reveal a number of distinctive characteristics and important interactions with the large-scale envi-
  ronment. The systems appear to be linked to eastward progression of a weak, middle-tropospheric, short-
  wave trough. Initial thunderstorms develop within a region of mesoscale convergence and lifting that is
  apparently forced primarily by low-level warm advection. The MCC system acquires mesoscale organization
  while it moves eastward ahead of the short-wave trough. Diabatic heating eventually produces a system
  that is warm core in the middle troposphere and cold core in upper levels. The mature MCC exhibits many
  similarities to tropical convective systems, although it occurs within a considerably different large-
  scale setting. Inflow within the lower half of the troposphere feeds convection within a region charac-
  terized by significant net upward mass flux and widespread precipitation. Thickness increases within this
  region produce anomalously high heights in the upper-troposphere above the MCC and intense outflow devel-
  ops in the region where the height gradient has increased. Decay typically occurs as the system moves
  east of the region of conditionally unstable air and low-level warm advection. However, as the system
  decays, atmospheric response to residual temperature perturbations results in intensification of the pre-
  cursor short-wave trough within the upper half of the troposphere.

WR-016
  R. A. MADDOX, L. W. Snellman, and A. H. Murphy. Forecaster training-overview of a panel discussion.
  Bulletin of the American Meteorological Society, 64:4:371-375 (1983).

No abstract.

WR-017

Walsh, P. A., R. F. REINKING, and J. B. CUNNING. Graupel characteristics in relation to the dynamics of Florida Cumuli. Preprints, Conference on Cloud Physics, November 15-17, 1982, Chicago, Illinois. American Meteorological Society, 362-366 (1982).

No abstract.

WR-018

WATSON, A. I., R. L. HOLLE, and D. O. BLANCHARD. The relationship between total area divergence and convective precipitation in south Florida and Illinois. Preprints, 9th Conference on Aerospace and Aeronautical Meteorology, June 6-9, 1983, Omaha, Nebraska. American Meteorological Society, Boston, 106-111 (1983).

The relationships between changes in total area divergence (area-averaged divergence) and convective precipitation were examined using surface data collected during the following two field experiments: 1975 Florida Area Cumulus Experiment (FACE) in south Florida and the 1979 University of Virginia, Illinois State Water Survey, and NOAA (VIN) program in east-central Illinois. The two mesonetworks covered areas between 1500 and 3000 km2 with station separations of 4 to 6 statue miles. It is possible with this technique to estimate in advance, with a reasonable degree of accuracy, area precipitation totals for a particular convective event. The technique can also be used to evaluate the degree of convective development or dissipation within the forecast region. In south Florida, the average time between initial convergence and initial rain was 35 minutes. The magnitude of the time change of total area divergence was statistically related to area rainfall based upon the criterion that a convergence event occurred anytime there was a sustained drop in total area divergence of less than $25 \times 10^{-6} s^{-1}$ for greater than 10 minutes. The difference between initial convergence and maximum convergence constituted the magnitude of the event, and this magnitude was related to total area precipitation, which was considered a product of the convergence. Based upon synoptic parameters, the output of rainfall can vary given the same amount of convergence. Correlations as high as .78 are found when conditions are moist and unstable.

WR-019

Weaver, J. F., and J. M. BROWN. Forecasting an unusual weather event in Colorado: 15 October 1980. Bulletin of the American Meteorological Society, 63:1142-1150 (1982).

On 15 October 1980, a weather system that had been to the west of Colorado was forecast to move into the state, and to bring with it light to moderate snow in the Rockies, and generally light rain and thundershower activity over the plains to the east. In most regions this forecast was adequate. However, substantially heavier activity (including a small tornado, large hail, heavy rain, and snow) also occurred in some areas. In this paper we show how all relevant real-time data, when properly merged, could have enabled formulation of a useful short-term forecast. In addition we point out how mesonet surface data gathered after the fact could have helped narrow down the forecast area of severe weather and heavy precipitation.

PR-001

BIRKENHEUER, D. Advanced technologies impact on short-term forecast. Preprints, Ninth Conference on Aerospace and Aeronautical Meteorology, June 6-9, 1983, Omaha, Nebraska. American Meteorological Society, Boston, 68-72 (1983).

During the past three years, the Prototype Regional Observing and Forecasting Service (PROFS) has been designing, building and testing advanced interactive forecaster workstations. These workstations have integrated present and possible future data sources from conventional surface data to Doppler Radar. Tests designed to measure the accuracies of short-term weather forecasts made using these advanced workstations are an ongoing part of the PROFS Program. Initial test results show that there is hope that such systems can favorably impact important and often vital short-term forecasts.

PR-002

BROWN, R. C. Anatomy of a mesoscale instrumentation system. Preprints, Fifth Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Ontario. American Meteorological Society, Boston, 308-313 (1983).

No abstract.

PR-003

GEORGE, D. H., editor. Urban snow and the potential value of PROFS. PROFS special report, Boulder, Colorado, 62 pp. (1983).

No abstract.

PR-004

PRATTE, J. F., Jr., and R. J. CLARK. The PROFS mesonet – description and performance. Preprints, Fifth Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Ontario. American Meteorological Socity, Boston, 303-307 (1983).

No abstract.

PR-005

RASMUSSEN, R. G., and T. W. SCHLATTER. Comparison of three analysis techniques for mesoscale nowcasting. Preprints, Sixth Conference on Numerical Weather Prediction, June 6-9, 1983, Omaha, Nebraska. American Meteorological Society, Boston, 175-182 (1983).

Many techniques have been employed over the past three decades for the objective analysis of meteorological data. In this paper, we compare the performance of three of these schemes with data provided by the 22-station PROFS mesonet. Two of these schemes (Cressman and optimum interpolation) are widely used but the third (Kalman-Bucy filter) is experimental. From a theoretical standpoint, the Cressman scheme takes an ad hoc approach to estimating meteorological fields at grid points. Optimum interpolation, on the other hand, allows for spatial correlation of the meteorological fields and for detailed specification of measurement errors for diverse observing systems. The Kalman-Bucy filter goes even further, with provision for continuous updating of system statistics and incorporation of equations describing the evolution of the true fields. In practice, however, there is no reason to expect a priori that one scheme will be better than another, and the extra computing resources required by the fancier schemes become an important consideration. Our paper will focus on comparison of mesoscale analyses over complex terrain, and specific examples of the performance of each scheme will be presented.

PR-006

REYNOLDS, D. W. Prototype workstation for mesoscale forecasting. Bulletin of the American Meteorological Society, 64: 264-273 (1983).

The PROFS (Prototype Regional Observing and Forecasting Service) Program has developed, implemented, and begun testing an interactive image/graphics display console for use in mesoscale forecasting. Called POWS (PROFS Operational Workstation), this hardware system is the first step toward PROFS's goal of

designing an innovative mesoscale forecasting system for use by the National Weather Service in the late 1980s or early 1990s. A brief description is given of the workstation design and hardware implementation. Examples of forecast products available on the system are shown, along with the many ways that products can be combined in a single display formal for each assimilation by the forecaster. Preliminary results from outside forecaster evaluations are given, as well as plans for real-time field testing and work-station upgrades.

PR-007
SCHLATTER, T. W., and D. V. BAKER. The 1982 Christmas Eve blizzard in northeast Colorado. <u>Weatherwise</u> 36: 60-66 (1983).

No abstract.

WM-001
NAGAMOTO, C., F. PARUNGO, and J. Hallett. Analysis of silver in individual ice particles after cloud seeding. Preprint Volume of Extended Abstracts: Conference on Cloud Physics, Nov. 15-18, 1982, Chicago, Ill. Published by the American Meteorological Society, Boston, Mass. (1982).

No abstract.

WM-002
NAGAMOTO, C.T., F. PARUNGO, R. REINKING, R. PUESCHEL and T. GERISH. Acid clouds and precipitation in eastern Colorado. Atmospheric Environment, 17(6):1073-1082 (1983).

Rain and snow samples were collected at the eastern foothills of the Rocky Mountains and analyzed for chemical composition. Many precipitation samples had pH values considerably more acidic than the 5.6 value of pure water containing only an equilibrium amount of atmospheric CO_2. Clear and considerable dependencies of the acidity on seasonal synoptic scale weather patterns are demonstrated. Cloud water samples, collected by aircraft over eastern Colorado, also showed low pH values. The acidity of clouds was greatest near the city of Denver.

WM-003
PARUNGO, F. Comments on "Measurements of cloud nuclei in the effluents from launches of liquid- and solid-fueled rockets." Journal of Climate and Applied Meteorology, 22(8): (1983).

No abstract.

WM-004
PARUNGO, F.P., and G. Langer. Comments on "Properties of pyrotechnic nucleants used in Grossversuch IV." Journal of Applied Meteorology, 21(10): (1982).

No abstract.

WM-005
PARUNGO, F., and C. NAGAMOTO. Case study of hydrometeors in Florida cumule. Preprint volume of extended abstracts conference on cloud physics, Nov. 15-18, 1982, Chicago, Ill. Published by the American Meteorological Society, Boston, Mass.

No abstract.

WM-006
PARUNGO, F.P., and H.K. WEIKMANN. Ice crystal growth at $(-8\pm2)°C$. J. Research Atmospheric, 17(2):139-155 (1983).

In investigations made on (1) snow crystals collected at ground level, (2) hydrometeors replicated in clouds, and (3) ice crystals produced in the laboratory, two major particle forms were observed at $(-8\pm2)°C$: non-crystalline frozen droplets and their conglomerates formed at water saturation; hexagonal thick plates or columns formed at ice supersaturation. The observations are explained as a consequence of the existence of a quasi-liquid layer on the ice surface. The thickness of the layer decreases with decreasing temperature and humidity. At $(-8\pm2)°C$ and water saturation, the ice crystal surface may be fully covered with this liquid-like layer thus preventing crystalline growth by conversion of vapor-to-ice. Instead, isometric growth takes place in two steps, first vapor to quasi-liquid layer, then quasi-liquid layer to ice. Frozen droplets are produced. Because of the quasi-liquid layer on their surface, the frozen droplets cohere easily on contact to form conglomerates or graupel. However, when the humidity decreases to ice saturation, the quasi-liquid layer disappears and vapor deposition growth becomes the main process to produce hexagonal crystals.

Two types of cloud water collectors were developed, and the devices were used to collect samples around
the Hawaii Islands. The chemical analyses of cloud water showed that Na^+, Cl^-, and SO_4 ion concentra-
tions were approximately 10^{-4} m; NH_4^+, NO_3^-, and Ca^{++} were 1 order of magnitude lower. The pH values were
in the range of 4-5 regardless of sampling locations. The high acidity of cloud water over Hawaii may
originate in the ocean or from long-range transport of anthropogenic pollution, in addition to local
pollution, if present.

GF-001
BENDER, M. A., and Y. KURIHARA, The energy budgets for the eye and eye wall of a numerically simulated tropical cyclone. Journal of the Meteorological Society of Japan 61(2):239-243 (1983).

Energy budgets are analyzed for a tropical cyclone simulated previously in a quadruply nested mesh model (Kurihara and Bender, 1982). It will be shown that the eddy kinetic energy within the eye is comparable in magnitude to that of the mean kinetic energy. It is supplied by import from the eye wall regions as well as by the conversion from total potential energy. At the same time it is converted to the kinetic energy of the mean flow and also lost by the dissipation. The influx of mean kinetic energy from the outer radii to the eye wall region and the export of potential energy both to the outer radii and to the eye region play important roles in the energetics of the eye wall region. Many obtained features agree well with those of a coarser resolution model (Tuleya and Kurihara, 1975) in which the eye of the vortex could not be resolved. This suggests that the eye structure has little impact on the energetics in the eye wall and outer regions of a tropical cyclone.

GF-002
Bowman, K.P. Sensitivity of an annual mean diffusive energy balance model with an ice sheet. Journal of Geophysical Research 87(C12):9667-9674 (1982).

The sensitivity of a diffusive energy balance model that contains a simple ice sheet is compared with that of a model with snow cover only. The effect of the elevated ice sheet surface on the radiative cooling is calculated by using a radiative transfer model. Because the temperature in the atmosphere decreases with height, the main effect of the ice sheet elevation is to reduce the outgoing infrared radiation. This reduction in the radiative cooling decreases the sensitivity of the ice sheet size to changes in the solar constant by partially counteracting the albedo feedback. For a reasonable choice of parameters, this effect can reduce the strength of the albedo feedback by a factor of 2.

GF-003
BRYAN, K. Poleward heat transport by the ocean. Reviews of Geophysics and Space Physics 21(5):1131-1137 (1983).

No abstract

GF-004
BRYAN, K. Seasonal variation in meridional overturning and poleward heat transport in the Atlantic and Pacific Oceans: a model study. Journal of Marine Research 40(Suppl):39-53 (1982).

Numerical solutions for a model of the World Ocean are analyzed to illustrate the important changes in the meridional circulation of the ocean induced by seasonal changes in wind stress. Seasonal variations of meridional circulation and associated changes in poleward heat transport predicted by the model are most important in the Pacific where the background thermohaline circulation is relatively weak. Numerical experiments show that seasonal variations of cross-equatorial heat transport basically depend on the variations of the zonal component of the wind stress. Seasonal variations of the meridional wind stress exert an influence on cross-equatorial heat transport which is 180° out of phase in the seasonal cycle from the more dominant influence of seasonal variations of the zonal wind stress.

GF-005
Carton, J. A. Adjustment in the oceans: The long-period tides and coastal upwelling, Ph.D. dissertation, Geophysical Fluid Dynamics Program, Princeton University, 1983.

This work is divided into two parts. The first part discusses the long-period tides in a bounded basin. As the period of the forcing increases, a region of equilibrium spreads westward from the eastern boundary, so that for periods as short as a month the equilibrium tide may be appropriate. Numerical integrations of the Mf and Mm tides are presented. The second part concerns the response to a series of distinct wind events, or it may be viewed climatologically as the response to stochastic forcing. The response of the coastal ocean to an alongshore wind event which is confined in space and time depends on the ratio of the time scale of the storm to the distance to the equatorward edge of the storm, divided by the speed of the alongshore waves. When this ratio is much greater than one the maximum alongshore velocity and upwelling occur during the passage of the storm. When this ratio is much less than one, the

maximum velocity and upwelling occur after the passage of the storm. The response outside the region of forcing and for different stratifications and topography are explored. In order to determine the correspondence between realistic atmospheric and oceanic variables, four years of North Pacific winds are used to drive a reduced gravity model. At periods less than 50 days the response is strongly trapped within a radius of deformation of the coast. At lower frequencies the alongshore pressure gradients are set up near shore, the curl of the wind stress becomes important, and the alongshore currents begin to disperse away from the eastern boundary in a series of jets, still strongly driven by the alongshore winds. A second model is used to investigate the effects of stratification and topography on eastern ocean circulation. Coherence between the alongshore wind stress and alongshore velocity is poor except in a band near 0.15 cpd. Other statistical relations are examined. An analysis of mass transport on the continental shelf indicates that at monthly periods, alongshore convergence of mass is important for supplying water to the surface layer.

GF-006
    COX, M. D. A numerical model of the ventilated thermocline. Ocean Modeling 49:5-7 (1983).

    No abstract

GF-007
    HAYASHI, Y., and D. G. GOLDER. Transient planetary waves simulated by GFDL general circulation models. Part I: Effects of Mountains. Journal of the Atmospheric Science 40(4):941-950 (1983).

    Space-time spectral analysis over a three year data set is made of transient planetary waves simulated by Geophysical Fluid Dynamics Laboratory (GFDL) spectral general circulation models with and without moun-mountains. In both models westward moving ultralong waves have larger geopotential amplitude than eastward moving ultralong waves, being in agreement with observations. In both models, westward moving ultralong waves are associated with little vertical tilt and a large meridional wavelength, while eastward moving ultralong waves are associated with some vertical tilt and a small meridional wavelength. In the absence of mountains westward moving ultralong waves are somewhat decreased, while eastward moving ultra-long waves are somewhat increased, and eastward moving wavenumber 4-6 components are markedly increased in the Northern Hemisphere.

GF-008
    HAYASHI, Y., and D. G. GOLDER. Transient planetary waves simulated by GFDL spectral general circulation models. Part II: Effects of Nonlinear Energy Transfer. Journal of the Atmospheric Sciences 40(4):941-950 (1983).

    In order to study how transient planetary waves in the midlatitude troposphere are maintained, a space-time spectral analysis over a 1-year data set is made of a GFDL spectral general circulation model. It is found that the kinetic energy (K_n) of both westward and eastward moving ultralong waves with periods less than 20 days is maintained primarily through conversion from wave available-potential energy (A_n). In particular, A_n of the westward moving ultralong waves is comparable to that of K_n and is maintained larger than K_n and is maintained primarily through the zonal-wave transfer of A_n and partly through the wave-wave transfer of A_n. These conclusions also hold in the absence of stationary-transient wave interactions as confirmed by a model with a uniform surface.

GF-009
    KURIHARA, Y., and M. A. BENDER. A numerical scheme to treat the open lateral boundary of a limited area model. Monthly Weather Review 111(3):445-454 (1983).

    A numerical scheme to treat the open lateral boundary of a limited-area primitive area equation model was formulated. Although overspecification of the boundary condition is inevitable in the pointwide boundary setting, the scheme was designed to keep the overspecifications to a minimum degree. To impose the boundary conditions, a damping technique was used. Special care was taken to deal with the boundary layer winds at the lateral boundary. The above scheme is most suitable when gravity waves do not prevail in the vicinity of the open boundary. The scheme was tested in the numerical integrations of prognostic equations for a Haurwitz-type wave. Experimental results are presented which indicate the utility of the proposed method.

GF-010
    LEVITUS, S. Climatological Atlas of the World Ocean. NOAA Professional Paper 13:188 pp. (1982).

This atlas contains maps of objective analyzed fields of temperature, salinity, dissolved oxygen and percent oxygen-saturation at standard oceanographic observation levels on a one-degree latitude-longitude grid for the world ocean. Maps of derived quantities such as geopotential thickness, Brunt-Vaisala frequency, and mixed-layer depths are also presented. The sources of data used in preparation of this atlas were the Station Data, Mechanical Bathythermograph, and Expendable Bathythermograph files of the National Oceanographic Data Center, Washington, D.C. Meridional cross-sections of the zonal averages of the objectively analyzed data are presented both in the form of figures and tables. Statistics on the number of observations, mean, and root-mean-square deviation of temperature, salinity, dissolved oxygen, percent oxygen-saturation, potential density, and specific volume on a five degree grid are presented in the microfische section of this atlas. Some discussion of the major oceanographic features observed in the various fields is given.

GF-011

LIPPS, F. B., and R. S. HEMLER. A scale analysis of deep moist convection and some related numerical calculations. Journal of the Atmospheric Sciences 39(10):2191-2210 (1982).

A scale analysis valid for deep moist convection is carried out. The approximate equations of motion are anelastic with the time scale set by the Brunt-Vaisala frequency. A new assumption is that the base state potential temperature is a slowly varying function of the vertical coordinate. It is this assumption that eliminates the energetic inconsistency discussed by Wilhelmson and Ogura (1972) for a non-isentropic base state. Another key result is that the dynamic pressure is an order of magnitude smaller than the first-order temperature and potential temperature. In agreement with observations, the kinetic energy is found to be an order of magnitude smaller than the first-order thermodynamic energy. A set of six numerical simulations representing moderately deep moist convection is carried out. The base state is an idealized mantime tropical sounding with no vertical wind shear. The first calculation (Run A) shows the growth and dissipation of a typical shower cloud. The remaining calculations have small changes in either initial conditions or model equations from Run A. These calculations indicate the sensitivity of the present model to different approximations and give additional evidence for the validity of the scale analysis.

GF-012

MacAyeal, D. R. Rectified tidal currents and tidal-mixing fronts: Controls on the Ross ice-shelf flow and mass balance. Ph.D. dissertation, Geophysical Fluid Dynamics Program, Princeton University, 1983.

Numerical simulations of tides, ocean circulations and ice-shelf flow conducted in this study contribute to present understanding of basal melting conditions below Antarctica's largest ice shelf. Having compared favorably with available observations, the simulations indicate the following results. Vorticity transport caused by tidal pumping across depth contours drives anticyclonic circulation about shallow sub-ice-shelf topography and along the ice front. Heat transported by this circulation accounts for approximately 0.5 ± 0.25 m/yr basal melting in the region within 150 km of the ice front. Tidally induced vertical mixing erodes stratification in the remote southeastern section of the sub-ice-shelf cavity where the ice shelf shoals. Efficient vertical heat transfer associated with this mixing catalyzes a large-scale thermohaline circulation having the following characteristics. A dense, high-salinity water mass that dominates the lower depths of the open Ross Sea, and that has a temperature $0.3°C$ warmer than the in siti melting point at the ice-shelf base, flows into the sub-ice-shelf cavity along the sea bed. On reaching the vertically well-mixed zone, this water mass is lifted into contact with the ice. Glacial meltwater produced by this contact flows out of the sub-ice-shelf cavity along the sloping ice shelf base and enters the open Ross Sea at mid-depth. Heat transported by this thermohaline flow accounts for apprroximately 0.05 m/yr basal melting in the tidally well-mixed areas. Finite-element ice-shelf flow simulations confirm previous contentions that basal melting increases ice-shelf resistance to deformation. By removing the warmest part of the ice column, basal melting induces a colder depth-averaged ice-shelf temperature and, therefore, higher ice-shelf viscosity. Observed resistance to deformation in regions along the ice front correspond with the basal-melting patterns associated with the simulated tidal rectification.

GF-013

MANABE, S. Carbon dioxide and climate change, In Advances in Geophysics 25, Theory of Climate, Barry Saltzman (ed.), Academic Press, New York, 355-490 (1983).

No abstract

GF-014
MANABE, S. Comments on paper Simulating CO_2-Induced Climate Change with Mathematical Climate Models: Capabilities, Limitations and Prospects by Michael E. Schlesinger. Proc. CO_2 Research Conference and Workshop, Sept. 19-23, 1982, Berkley Springs, WV, III.145-159 (1983).

No abstract

GF-015
MANABE, S. Simulation of climate by general circulation models with hydrologic cycles. In Land Surface Processes in Atmospheric General Circulation Models, P.S. Eagleson (ed.), Cambridge University Press, 19-66, (1982).

This paper describes the basic structure of a typical general circulation model of the atmosphere and that of the joint ocean atmosphere system. It discusses some alternate approaches to the construction of key components of a model. In addition, the present state of the art in climate simulation is discussed with reference to the climates produced by some of the models devveloped at the Geophysical Fluid Dynamics Laboratory. Special emphasis is placed upon the description of the hydrologic aspect of the simulation. Finally, the future strategies for model improvement are suggested.

GF-016
MANABE, S., and R. J. STOUFFER. Seasonal and latitudinal variation of the CO_2 induced change in a climate of an atmosphere-mixed layer ocean model. Proceedings DOE Workshop on First Detection of Carbon Dioxide Effects, June 8-10, 1981, Harpers Ferry, West Virginia, 79-94 (1980).

No abstract

GF-017
Mellor, G. L., C. R. Mechoso, and E. Keto. A diagnostic calculation of the general circulation of the Atlantic Ocean. Deep-Sea Research, 29(10A):1171-1192 (1982).

The general circulation of the Atlantic Ocean is calculated from the low Rossby number equations of motions where all frictional terms except surface wind stress are neglected. Climatological sea surface wind stress, temperrature, and salinity, and bottom topography are inputs of the calculation. Total transport is calculated by integrating the vertically integrated equations of motion along contours of constant planetary potential vorticity, f/H, where f is the Coriolis parameter and H is the local depth. The integration begins on the eastern boundary of the ocean where the total transport is assumed to be zero. Results are also obtained for three transport components; Ekman transport, thermohaline transport, and bottom velocity transport. Despite the rather crude 1° x 1° calculation grid, the results show considerable detail particularly in the higher latitude Atlantic Ocean. The calculations yield about a $25 \times 10^6 m^3 s^{-1}$ transport through the Straits of Florida increasing to a maximum Gulf Stream transport of about 90; about $25 \times 10^6 m^3 s^{-1}$ of this is entrained flow from a southwestward, nearly barotropic flow along the Middle Atlantic Bight continental slope. Unlike the wind-drive, constant depth, Sverdrup transport result, total transport streamlines are closed in the western boundary without need of bottom or lateral friction in the governing equations.

GF-018
Mellor, G. L., and T. Yamada. Development of a turbulence closure model for geophsical fluid problems. Reviews for Geophysical and Space Physics 20(4):851-875 (1982).

Applications of second-moment turbulent closure hypotheses to geophysical fluid problems have developed rapidly since 1973, when genuine predictive skill in coping with the effects of stratitication was demonstrated. The purpose here is to synthesize and organize material that has appeared in a number of articles and add new useful material so that a complete (and improved) description of a turbulence model from conception to application is condensed in a single article. It is hoped that this will be a useful reference to users of the model for application to either atmospheric or oceanic boundary layers.

GF-019
Mesinger, F., and R. F. Strickler. Effect of mountains on Genoa cyclogeneses. Journal of the Meteorological Society of Japan 60(1):326-338 (1983).

Four cases of cyclogenesis in the Gulf of Genoa (so-called Genoa cyclogeneses) have been simulated using a high resolution prediction model. Integrations are performed for a 48 hour period, using observed boundary conditions, and for each case with and without mountains in the model. It is found that in two of these cases cyclogenesis happens irrespective of the presence of mountains. However, mountains have a strong modifying influence in ridging at the surface to the northwest and to the southwest of the Alpine obstacle, and at mid-troposphere in ridging in central Europe north of the Alps. Of the two cases in which cyclogenesis does not happen without mountains, in one case a very realistic simulation of the surface development is obtained. In mid-troposphere, although simulated geopotential heights are even less than observed, the intensity of the cutoff processes north of the Genoa region is not sufficiently realistic. It is suggested that, therefore, the problem is either in an insufficient intensity of blocking north of the obstacle or in a process of a more large scale nature.

GF-020
MIYAKODA, K. Surface boundary forcings. WMO/ICSU Study Conference on Physical Basis for Climate Prediction on Seasonal, Annual, and Decadal Time Scales, Leningrad, 13-17 September 1982, World Climate Research Programme, WCP-47, 51-78 (1983).

No abstract

GF-021
MIYAKODA, K., T. GORDON, R. Caverly, W. STERN, R. SIRUTIS, AND W. Bourke. Simulation of a blocking event in January 1977. Monthly Weather Review 111(4):846-869 (1983).

January 1977 was a month noted for its extraordinary weather over North America. The winter was dominated by two persistent large amplitude ridges positioned over the west coast of North America and the Icelandic region of the Atlantic Ocean. A very intense trough reached deep in the eastern United States and caused one of the coldest Januaries on record. One-month integrations of various GCM's were conducted in order to test their ability to simulate this blocking event. Reasonably high resolution finite differences and spectral models available at GFDL were used. Each GCM was integrated from three different analyses of the initial conditions. For some models, a fairly accurate forecast was obtained and considerable skill was recognized in the simulation of the 30-day evolution in terms of the 5-day or 10-day mean flow fields, including the period of record breaking coldness over the eastern United States. The main conclusion is that proper treatment of the subgrid-scale processes as well as sufficient spatial resolution are essential for the simulations of this phenomenon as an initial value problem. Weak Zonal wind poleward of about 40°N and upstream of the blocking ridge appears to be crucial for the successful simulation of the sustained blocking ridge.

GF-022
OORT, A. H., Climate variability - some observational evidence. WMO/ICSU Study Conference on Physical Basis for Climate Prediction on Seasonal, Annual, and Decadal Time Scales, Leningrad, 13-17 Sept. 1982, World Climate Research Programme, WCP-47, 1-24 (1983).

No abstract

GF-023
OORT, A. H., and J. P. Peixoto. Global angular momentum and energy balance requirements from observations. In Advances in Geophysics 25, Theory of Climate, Barry Saltzman (ed.), Academic Press, New York 355-490 (1983).

No abstract

GF-024
Palmer, T. N., and C.-P. F. Hsu. Stratospheric sudden coolings and the role of nonlinear wave interactions in preconditioning the circumpolar flow. Journal of the Atmospheric Sciences 40(4):909-928 (1983).

In a series of idealized numerical experiments, Butchart et al. (1982) have recently established that the configuration of the mean zonal wind occurring immediately before the wavenumber-2 major stratospheric warming of February 1979 was crucial in subsequently focusing upward propagating planetary wave-activity into the high latitude stratosphere. In this sense, it was concluded that the stratospheric circumpolar flow should evolve to some preconditioned state before a wavenumber-2 major warming could occur. In the present paper, the mechanisms responsible for the transition of the circumpolar flow from its normal mid-

winter state to this preconditioned state are investigated through a combination of observational numerical and theoretical studies. For the 1978-79 winter, this transition occured during the substantial wavenumber-1 minor warming of January 1979, and the characteristic structure associatead with the preconditioned mean zonal flow was established four days after the peak of this warming, during a period of intense high latitude acceleration. This latter phenomenon is referred to as a stratospheric sudden cooling. Observations of Eliassen-Palm flux cross-sections indicate that while wave, zonal mean-flow interaction theory could account for the qualitative evolution of the circumpolar flow during the warming, substantial nonlinear wave interactions were active during the cooling period, and these interactions significantly influenced the evolution of the circumpolar flow. In a series of numerical experiments using a truncated semi-spectral model, we show that this sudden cooling phenomenon can be realistically reproduced in an idealized integration in which wave-wave interactions are present. By contrast, we were unable to simulate this phenomenon with these interactions removed. Two different mechanisms are put forward to account for these nonlinearities. One mechanism is that of wave-breaking and associated potential vorticity mixing, as suggested by McIntyre (1982). The second mechanism is based on the notion of wave-activity, forced in the troposphere, propagating relative to isopleths of potential vorticity of some zonally asymmetric basic state. Results of the observational and numerical study suggest that the first mechanism was dominant, and that potential vorticity mixing in the outer regions of the polar vortex was central to the process of preconditioning. Nevertheless, we believe that the second mechanism plays an important role in the dynamics of the stratosphere.

GF-025
   Peixoto, J. P., and A. H. OORT. The atmospheric branch of the hydrological cycle and climate. In
   Variations in the Global Water Budget, A. Street-Perrott et al. (eds.), D. Reidel, Holland, 5-65
   (1983).

   Based on daily observations from about 1000 rawinsonde stations, tables and global distributions of the various water vapour fields are presented for mean annual, winter and summer conditions covering the 10-year period, May 1963 through April 1973. The fields include horizontal maps of precipitable water, to total zonal, meridional and vertical transports by eddy and mean circulations, as well as meridional profiles and zonal mean cross-sections of these quantities. The connections between the atmospheric branch and the hydrology of the Earth's surface were studied with the aid of the divergence fields of mean total water vapour flux and through horizontal and vertical streamfunction analyses. The divergence maps agree quite well with maps of evaporation minus precipitation (E-P) obtained from classic, climatological surface data. Over the oceans, the divergence fields show a good correlation with the evaporation and surface salinity maps. From the zonal mean streamfunction analyses, the total vertical transports of water substance were inferred, and compared with the contributions by standing eddies and mean meridional circulations. The resulting vertical fluxes by transient eddies show the great importance of cumulus convection in the tropics for the atmospheric circulation. The main sources and sinks of atmospheric water vapour, as well as the dominant mean trajectories of water, are identified. In the light of various climatological and oceanographic considerations, the results show that the study of the atmospheric branch is essential to improve understanding of the Earth's water balance on both regional and global scales.

GF-026
   PHILANDER, S.G.H. El Nino Southern Oscillation phenomena. Nature 302(5906):295-301 (1983).

   At intervals that vary from 2 to 10 year sea-surface temperatures and rainfall are unusually high and the tradewinds are unusually weak over the tropical Pacific Ocean. These Southern Oscillation El Nino events which devastate the ecology of the coastal zones of Ecuador and Peru, which affect the global atmospheric circulation and which can contribute to severe winters over northern America, often develop in a remarkably predictable manner. But the event which began in 1982 has not followed this pattern.

GF-027
   PIERREHUMBERT, R. T. Bounds on the growth of perturbations to non-parallel steady flow on the
   barotropic beta plane. Journal of the Atmospheric Sciences, 40(5):1207-1217 (1983).

   Based on considerations of the perturbation enstrophy and energy equations, we have derived a general family of bounds on the growth rates of perturbations to non-parallel (vortex-like or wave-like) flow on the barotropic beta-plane, allowing for the effects of forcing, Ekman friction, and topography. The family of bounds generalizes Arnold's stability criterion. A number of specific applications of the family of bounds are explored. In particular, the formulas are used to demonstrate that the growth rate of the perturbations must vanish if the perturbation length-scale approaches zero or infinity. The distinction between transient and sustained growth of perturbation energy is discussed in light of our results. It is suggested that the bounds are most useful for estimating transient growth rates.

GF-028
   PLOSHAY, J. J., R. K. WHITE, AND K. MIYAKODA. FGGE level III-B daily global analyses. Part I
   (Dec 1978 - Feb 1979). NOAA-ERL-GFDL-1, 278 pp. (1983).

   No abstract

GF-029
   Redi, Martha H. Oceanic isopycnal mixing by coordinate rotation. Journal of Physical Oceanography,
   12(10):1154-1158 (1982).

   Current numerical models of oceanic circulation differentiate between the Eddy diffusion and viscosity
   transport along the geopotential horizontal and vertical directions only. In order to model the effect
   of anisotropic turbulence as diffusive transport along and across density surfaces, the isopycnal mixing
   tensor has been transformed from a diagnoal second-rank tensor in the isopycnal coordinate system to a
   tensor containing off-diagonal elements in the geopotential coordinate system.

GF-030
   Sardeshdmukh, P. D. Mechanisms of monsoonal cyuclogenesis. Ph.D. dissertation, Princeton University,
   1983.

   The relationship between snyoptic-scale disturbances of the Southwest Monsoon and the large scale
   circulation in which they are embedded is examined. Barotropic and baroclinic instability of the mean
   monsoonal flow is studied. A monsoon-like disturbance simulated by a high resolution atmospheric general
   circulation model is analyzed. The model's July mean vorticity balance at 200 mb is studied in detail
   to assess the effect of transients of all scales on the large scale flow in the tropics. Some conclu-
   sions that may be drawn from this work are: the zonally varying lower tropospheric monsoonal flow is
   barotropically unstable. Rapid localized growth can occur by this process in certain preferred geo-
   graphical regions such as the Bay of Bengal; the upper tropospheric tropical easterly jet is baro-
   tropically as well as barotropically unstable. The characteristics of the most unstable modes compare
   favourably with those of observed waves in the easterlies. These modes are confined to the upper tro-
   posphere, but modes of slightly longer wavelength, with only slightly lower growth rates, penetrate to
   the ground with appreciable amplitude; it is difficult to obtain baroclinically unstable modes with maxi-
   mum amplitude in the lower troposphere. Including the mean meridional wind in the analysis only introdu-
   ces slowly growing modes of very large length scale. These modes can be isolated in a 2-level model; a
   detailed local vorticity budget analysis of the monsoon-like disturbance simulated by a GFDL GCM shows
   that the latent heat of condensation plays a dominant role in its dynamics from a very early stage. A
   controlled experiment in which this latent heat release is not allowed to drive the circulation indeed
   results in no appreciable development of the eddy; the effect of the distrubances on the time-mean, large
   scale flow, as manifested in transience terms in time mean vorticity budgets evaluated at several vertical
   levels in the model's tropics, is found to be very small, in contradiction to claims often made in the
   literature concerning the importance of vertical mixing of horizontal momentum by cumulus convection. No
   such transport is included in the model's moist convective adjustment scheme, and yet the model does
   reproduce all the main features of the steady large scale tropical circulation, such as the location of
   the Tibetan anticyclone.

GF-031
   Sarmiento, J. L., C. G. H. Rooth, and W. S. Broecker. Radium 228 as a tracer of basin wide processes
   in the abyssal ocean. Journal of Geophysical Research, 87(C12):9694-9698 (1982).

   A simple model of isopycnal mixing in a circular basin is developed in order to examine the utility of
   the 5.75 year half-life tracer radium 228 for studying basin wide processes in the deep ocean. The model
   shows that it is possible to resolve diffusivities of $\leq 8 \times 10^7$ cm^2 s^{-1} in a basin of $\sim$3000-km diameter
   with profiles measured near the center and edge of the basin. A least squares fit of the model to four
   abyssal profiles measured during GEOSECS in the North American basin gives an isopycnal diffusivity of
   6×10^7 cm^2 s^{-1}.

GF-032
   SMAGORINSKY, J. Large-scale climate modeling and small-scale physical processes. Land Surface
   In Processes in Atmospheric General Circulation Models, P. S. Eagleson (ed.), Cambridge University
   Press, 3-17 (1982).

   No abstract

GF-033
    SMAGORINSKY, J. The beginnings of numerical weather prediction and general circulation modeling: early recollections. In <u>Advances</u> in <u>Geophysics</u> 25, <u>Theory</u> <u>of</u> <u>Climate.</u> Barry Saltzman (ed.), Academic Press, New York, 3-38 (1983).

    No abstract

GF-034
    SMAGORINSKY, J. Climate changes due to CO_2. <u>AMBIO, A Journal</u> <u>of</u> <u>the</u> <u>Human</u> <u>Environment,</u> Royal Swedish Academy of Sciences XII(2):83-85 (1983).

    No abstract

GF-035
    TULEYA, R. E., and Y. KURIHARA. A note on the sea surface temperature sensitivity of a numerical model of tropical storm genesis. <u>Monthly</u> <u>Weather</u> <u>Review</u> 110(12):2063-2069 (1982).

    In a three-dimensional numerical model of a tropical disturbance, a spectrum of development stages, from a weakening wave to a mature tropical storm, was obtained with a 5 K range (298 to 303 K) sea surface temperature (SST). However, the apparently large SST sensitivity of the model was found to be modulated by other factors including the large-scale environmental temperature and humidity. Through the use of this model, problems concerning a critical value of SST necessary for storm development were discussed.

GF-036
    WELSH, J. G. Geophysical Fluid Simulation on a parallel computer. In <u>Parallel</u> <u>Computations,</u> Garry Rodrigue (ed.), Academic Press, 269-277 (1982).

    No abstract

GF-037
    Yeh, T.-C., R. T. WETHERALD, and S. MANABE. A model study of the short-term climatic and hydrologic effects of sudden snow-cover removal. <u>Monthly</u> <u>Weather</u> <u>Review</u> 111(5):1013-1024 (1983).

    This paper describes the results from a set of numerical experiments which stimulate the effect of a large-scale removal of snow cover in middle and high latitudes during the early spring season. This is done through use of a simplified general circulation model with a limited computational domain and idealized geography. It is found that removal of snow cover reduces the water available to the soil through snowmelt and decreases soil moisture in this region during the following seasons. Furthermore, it also reduces surface albedo in this region and increases absorption of insolation by the ground surface. This, in turn, heats the ground surface and allows more evaporation to occur. However, the change of evaporation is realatively small owing to the low values of surface temperature in high latitudes. Therefore, the negative anomaly of soil moisture induced initially by the removal of snow cover persists for the entire spring and summer seasons. The removal of snow cover also affects the thermal and dynamical structure of the atmosphere. It is found that the increase of surface temperature extends into the upper troposphere thereby reducing both meridional temperature gradient and zonal wind in high latitudes.

GF-038
    Yoon, J.-H., and S. G. H. PHILANDER. The generation of coastal undercurrents. <u>Journal</u> <u>of</u> <u>the</u> <u>Oceanographical</u> <u>Society</u> <u>of</u> <u>Japan</u> 38: 215-224 (1982).

    Equilibrium conditions in an f-plane ocean evolve as follows after the sudden onset of winds parallel to a coast. At first the flow is two-dimensional - spatial variations are confined to a plane perpendicular to the coast - and the salient features in the forcing region are acceleration of a coastal jet in the surface layers in the wind direction, and the offshore Ekman drift that causes coastal upwelling. Kelvin waves excited at the edge of the forced region establish equilibrium conditions by creating an alongshore pressure gradient that balances the wind so that the acceleration stops. The vertical structure corresponding to each vertical mode differs from that of the wind-driven coastal jet so that the arrival of the barotropic Kelvin waves starts to accelerate a coastal undercurrent in a direction opposite to that of the wind. Subsequent baroclinic Kelvin waves modify the vertical structure of the coast current so that the undercurrent in the subsurface layer is accelerated. In an inviscid model there is a

singularity in the surface layers at the coast as $t \rightarrow \infty$ because the Kelvin modes with small offshore and vertical scales travel slowly and take a very long time to make their contribution to the establishment of equilibrium conditions. A modest amount of friction eliminates this problem. Nonlinearities are important in the heat equation and affect sea surface temperature significantly but their effect on the momentum balance is secondary.

GF-039
   Zeng, Qing-cun. The evolution of a Rossby-wave packet in a three-dimensional baroclinic atmosphere.
   Journal of the Atmospheric Sciences 40(1):73-84 (1983).

   The development of an individual quasi-geostrophic disturbance in a three-dimensional baroclinic atmosphere is investigated by using a wave-packet representation and the WKB method. The results obtained indicate that the development of a Rossby-wave packet in the upper level of the atmosphere depends on the packet's structure and location with respect to the zonal flow, whether the zonal flow is stable or not. The wave packet develops (decays) if the three-dimensional rays are directed up-gradient (down-gradient) in the zonal flow. All characteristics of the wave packet are changing with time. The spatial scale or the three-dimensional wavelength of the developing (decaying) wave packet increases (decreases). The tilt of barotropic decaying (developing) trough line away from the meridian increases (decreases), while the vertical tilt of the baroclinic decaying (developing) trough line away (out from) the jet region, if the zonal flow is stable. Unlike a single normal mode, most wave packets cause considerable divergence of momentum and heat flux; hence there exists strong interaction between a Rossby-wave packet and the zonal flow.

GL-001
  ASSEL, R. A. A computerized ice concentration data base for the Great Lakes. NOAA-DR-ERL-GLERL-24
  (PB83 233031), 25 pp. (1983).

  A 20-winter computerized ice concentration data base was established for the Great Lakes. This report
describes the computerized data set and an ice concentration climatology developed from it. Data reduc-
tion and analysis procedures, computer file structure and record format, and availability of the data are
given.

GL-002
  ASSEL, R. A. Description and analysis of a 20-year (1960-79) digital ice-concentration database for
  the Great Lakes of North America. Annals of Glaciology 4:14-18 (1983).

  A digital ice-concentration database spanning 20 years (1960 to 1979) was established for the Great
Lakes of North America. Data on ice concentration, i.e., the percentage of a unit surface area of the
lake that is ice-covered, were abstracted from over 2,800 historic ice charts produced by United States
and Canadian government agencies. The database consists of ice concentrations ranging from zero to 100%
in 10% increments for individual grid cells of size 5 x 5 km constituting the surface area of each Great
Lake. The data set for each of the Great Lakes was divided into half-month periods for statistical anal-
ysis. Maximum, minimum, median, mode, and average ice-concentration statistics were calculated for each
grid cell and half-month period. A lakewide average value was then calculated for each of the half-month
ice-concentrations statistics for all grid cells for a given lake. Ice-cover variability and the normal
extent and progression of the ice cover is discussed within the context of the lakewide averaged value of
the minimum and maximum ice concentrations and the lakewide averaged value of the median ice concentra-
tions, respectively. Differences in ice-cover variability among the five Great Lakes are related to mean
lake depth and accumulated freezing degree-days. A Great Lakes ice atlas presenting a series of ice
charts which depict the maximum, minimum, and median ice-cover concentration for each of the Great Lakes
for nine half-monthly periods, starting the last half of December and continuing through the last half of
April will be published in 1983 by the National Oceanic and Atmospheric Administration (NOAA). The data-
base will be archived at the National Snow and Ice Data Center of the National Environmental Satellite
Data and Information Service (NESDIS) in Boulder, Colorado, USA, also in 1983.

GL-003
  ASSEL, R. A. Lake Superior bathythermograph data: 1973-79. NOAA-DR-ERL-GLERL-25 (PB83 252890), 21 pp.
  (1983).

  Temperature surveys were made across an east-west transect of Lake Superior during the 1973, 1974, 1975,
and 1976 winter seasons and the 1976, 1977, 1978, and 1979 autumn seasons. A portable bathythermograph
recorder measured water temperatures along the transect to a maximum depth of 200 m. There were 46 tem-
perature surveys made, with an average of 24 temperature profile measurements per survey. This report
presents tabulations of 39 of the 46 temperature surveys, along with isothermal contour charts portraying
the thermal structure of the lake and station position charts showing the location of each temperature
profile for all 46 surveys. Temperature tabulations from the 1973 and 1974 winters were published in a
previous report.

GL-004
  AUBERT, E. J., and T. L. Richards (eds.). IFYGL--The International Field Year for the Great Lakes.
  Great Lakes Environmental Research Laboratory, Ann Arbor, 420 pp. (1981). (Published in 1983.)

  No abstract.

GL-005
  AUBERT E. J., and T. L. Richards. Summary of accomplishments. In IFYGL--The International Field Year
  for the Great Lakes, E. J. Aubert and T. L. Richards (eds.), Great Lakes Environmental Research
  Laboratory, Ann Arbor, 367-384 (1981). (Published in 1983.)

  No abstract.

GL-006

BENNETT, J. R., A. H. CLITES, and D. J. SCHWAB. A two-dimensional lake circulation modeling system: Programs to compute particle trajectories and the motion of dissolved substances. NOAA-TM-ERL-GLERL-46 (PB83 257014), 55 pp. (1983).

This report documents two computer programs that use currents from numerical lake circulation models to predict the motion of particles and dissolved substances. Movement of particles in the water is related to the vertically averaged current and to a percentage of the surface wind. Dissolved substances are assumed to be vertically mixed and thus to move only with the current. The user must provide bathymetric data, initial conditions, currents, winds, and a subroutine to generate output. The programs are very general and, though designed to be used with the hydrodynamic models and bathymetric grid generation programs documented in earlier GLERL technical memoranda, can be easily adapted to use input from other sources.

GL-007

Bowling, J. W., G. J. Leversee, P. F. LANDRUM, and J. P. Giesy. Acute mortality of anthracene-contaminated fish exposed to sunlight. Journal of Aquatic Toxicology 3:79-90 (1983).

Acute mortality of bluegill sunfish (Lepomis macrochirus) dosed with anthracene at 12.7 µg/l and exposed to natural sunlight conditions was observed during a study of anthracene fate in outdoor channel microcosms. No mortality was observed under control conditions (natural sunlight and no anthracene). Fish survived when held in the shade downstream of sunlit contaminated water, arguing against mortality due to toxic anthracene photoproducts in the water. Fish held 48 h in anthracene contaminated water (~12 µg/l), in a shaded channel, died when placed in clean water and exposed to sunlight. After 144 h depuration in darkness, fish anthracene concentrations had decreased to pre-exposure concentrations and no mortality was observed when fish were subsequently exposed to sunlight. This observed photo-induced toxic response in anthracene contaminated fish may represent a significant environmental hazard of polycyclic aromatic hydrocarbons in aquatic environments.

GL-008

CROLEY, T. E., II. Great Lakes basins (U.S.A.-Canada) runoff modeling. Journal of Hydrology 64:135-158 (1983).

Large-scale watershed models are required in order to estimate basin runoff to the Great Lakes for use in routing determinations and operational hydrology studies. Data limitations, large-basin applicability and economic efficiency preclude the use of existing large-watershed models. This paper describes an interdependent tank-cascade model that uses a mass balance coupled with linear reservoir concepts. It is physically based and uses climatological considerations not possible for small watersheds; it employs analytical solutions to bypass numerical inaccuracies. Snowmelt and net-supply computations are separable from the mass-balance determinations and are based on a simple heat balance. Partial-area concepts are used to determine infiltration and surface runoff. Losses are determined from joint consideration of available energy for evapotranspiration and of available moisture in the soil horizons by using climatologic concepts. Also described are heuristic calibration procedures that give insight into the use of the model. The model is applied, for a 30-day computation interval, to the Genesee River Basin in New York State and compared with past 6-h computation interval applications of the Streamflow Synthesis and Reservoir Regulation (SSARR) and National Weather Service Hydrologic (NWSH) models to the same data set.

GL-009

CROLEY, T. E., II. Sediment dynamics in unsteady nonprismatic rills. Proceedings, Conference on Frontiers in Hydraulic Engineering, H. T. Shen (ed.), Cambridge, Massachusetts, August 9-12, 1983. American Society of Civil Engineers, New York, 127-132 (1983).

Overland sedimentation in unsteady nonprismatic rills under uniform rainfall excess appears to be well described with kinematic models of flow, entrainment, and deposition applied to developing flow geometries; this is not possible with sheet-flow mdoels. Sediment concentration and flow data are analyzed by extending the theory developed for prismatic channels. Excellent agreement between theory and experimental results at several rainfall rates is demonstrated here for one high rainfall rate. The rills proceed (in both time and space) from narrow and (relatively) deep channels (early or upstream) to wide and shallow (later or downstream), resulting in a decrease of average velocity with increasing flow thereby increasing deposition. A reversal of sediment and flow characteristic times is apparent, compared with prismatic channel analyses, since the flow velocity, v, decreases with increasing flow area, A (dv/dA < 0).

GL-010
CROLEY, T. E., II. A tank-cascade runoff model for large forested basins. Proceedings, Canadian Hydrology Symposium '82: Hydrological Processes of Forested Areas, Fredericton, New Brunswick, June 14-15, 1982. Associate Committee on Hydrology, National Research Council Canada, Ottawa, Ontario, 419-440 (1982).

Large-scale watershed models are required to estimate basin runoff to the Great Lakes ror use in routing determinations and operational hydrology studies. Data limitations, large-basin applicability, and economic efficiency preclude the use of existing large-watershed models. This paper describes an interdependent tank-cascade model that uses a mass balance coupled with linear reservoir concepts. It is physically based and uses climatological considerations not possible for small watersheds; it employs analytical solutions to bypass numerical inaccuracies. Snowmelt and net supply computations are separable from the mass balance determinations and are based on a simple heat balance. Partial area concepts are used to determine infiltration and surface runoff. Losses are determined from joint consideration of available energy for actual and potential evapotranspiration and of available moisture in the soil horizons by using climatological concepts, especially relevant for large data-poor forested areas. The model is applied, for a 30-day computation interval, to the Genesee River Basin in New York State and compared with past 6-hr computation interval applications of the Streamflow Synthesis and Reservoir Regulation and National Weather Service Hydrologic models to the same data set. Results are summarized also for 11 other large watersheds about Lake Ontario.

GL-011
CROLEY, T. E., II, and H. C. HARTMANN. Lake Ontario Basin runoff modeling. NOAA-TM-ERL-GLERL-43 (PB83 237420), 114 pp. (1983).

An interdependent tank-cascade model of basin runoff, employing analytical solutions of climatological considerations relevant for large watersheds, has been developed. The mass balance is coupled with physically-based concepts of linear reservoir storages, partial-area infiltration, complementary evapotranspiration and evapotranspiration opportunity based on available supply, and heat balance determinations of snowmelt and net supply. Daily air temperature, precipitation, and runoff data are required for calibration of the nine parameters; data are grouped for 15 watersheds about Lake Ontario, as well as for the entire basin above Elevator, N.Y., and Kingston, Ont. The model has been applied to the Lake Ontario Basin in both lumped- and distributed-parameter approaches; 11 subbasins and 2 basins have been modeled for 7-d and 30-d mass balance computation intervals. Parameter values have been interpreted for physical meaning and relation to data errors and computation intervals. Temporal and spatial integration effects have been analyzed with respect to error reduction, modeling information and resolution, and cost trade-offs. The model is an accurate, fast representation of weekly or monthly runoff volumes from large watersheds with simple calibration and data requirements. Parameter values have physical significance and appear reasonable and consistent.

GL-012
EADIE, B. J., W. R. FAUST, P. F. LANDRUM, N. R. MOREHEAD, W. S. GARDNER, AND T. F. NALEPA. Bioconcentrations of PAH by some benthic organisms. Polynuclear Aromatic Hydrocarbons: Seventh International Symposium on Formation, Metabolism, and Measurement, M. W. Cooke and A. J. Dennis (eds.), Columbus, Ohio, October 26-28, 1982. Battelle Press, Columbus, Ohio, 437-449 (1982).

No abstract.

GL-013
EADIE, B. J., J. A. ROBBINS, P. F. LANDRUM, C. P. Rice, M. S. Simmons, M. J. McCORMICK, S. J. Eisenreich, G. L. BELL, R. L. PICKETT, K. Johansen, R. Rossman, N. HAWLEY, and T. Voice. The cycling of toxic organics in the Great Lakes: A 3-year status report. NOAA-TM-ERL-GLERL-45 (PB83 256792), 174 pp. (1983).

This interim 3-year status report describes the results of GLERL's studies on the cycling of toxic organics in the Great Lakes. A hierarchy of models has been developed including 1) a lake-scale equilibrium model, 2) a one-dimensional steady-state model, 3) one- and two-dimensional time dependent models, and 4) several individual process models. These modeling efforts have identified process research needs, some of which have been supported. Reported here are results of our work on: 1) air-water exchange; 2) photolysis; 3) sorption and partitioning; 4) particle settling and transport; 5) early diagenetic processes in lake sediments; 6) interaction of sediments, contaminants, and benthic organisms; and 7) simulation studies of organic contaminants.

GL-014
  Edgington, D. N., and J. A. ROBBINS. Patterns of deposition of natural and fallout radionuclides in the sediments of Lake Michigan and their relation to limnological processes. In Environmental Biochemistry, J. O. Nriagu (ed.), Ann Arbor Science, Ann Arbor, 705-729 (1983).

  No abstract.

GL-015
  Fraser, A. S., and A. ROBERTSON. Materials balance. In IFYGL--The International Field Year for the Great Lakes, E. J. Aubert and T. L. Richards (eds.), Great Lakes Environmental Research Laboratory, Ann Arbor, 341-352 (1981). (Published in 1983.)

  No abstract.

GL-016
  GARDNER, W. S., and P. F. LANDRUM. Characterization of ambient levels of ultraviolet-absorbing dissolved humic materials in natural waters by aqueous liquid chromatography. In Aquatic and Terrestrial Humic Materials, R. F. Christman and E. T. Gjessing (eds.), Ann Arbor Science, Ann Arbor, 203-217 (1982).

  Ambient levels of ultraviolet-absorbing dissolved organic materials of river, lake and sediment pore water filtrates were fractionated into chemically distinct groups by high-performance, distilled water, size exclusion chromatography. When the mobile phase was distilled water, fractionation apparently depended on compound polarity, as well as on molecular weight. Water samples (0.5 ml) were analyzed directly on a TSK 3000 sw size exclusion column with ultraviolet (UV) detection. The chemical character of the three (or four) resolved peaks was examined by pretreatments, including ultracentrifugation; passage through cation exchange, anion exchange, and reverse phase columns; metal addition; and dialysis. The first two peaks could be removed by anion exchange (but not by reverse phase or cation exchange) pretreatment. Components of the third peak were not quantitatively removed by anion exchange, cation exchange, or reverse phase pre-treatments. Peak 4, found only in sediment pore water, was removed by reverse phase pretreatment but not by anion or cation exchange. The addition of Na, Ca, or Cu to filtrates resulted in removal of peaks 1 and 2, with a concomitant increase in peak 3. Peak 1 was removed progressively less efficiently by Cu, Ca and Na, but in contrast, peak 2 was removed by similar levels of each respective metal. Thus, when distilled water was used as the mobile phase, components of each UV-absorbing peak exhibited unique chemical characteristics.

GL-017
  GARDNER, W. S., and J. M. MALCZYK. Discrete injection segmented flow analysis of nutrients in small-volume water samples. Analytical Chemistry 55:1645-1647 (1983).

  No abstract.

GL-018
  GARDNER, W. S., T. F. NALEPA, D. R. SLAVENS, and G. A. LAIRD. Patterns and rates of nitrogen release by benthic Chironomidae and Oligochaeta. Canadian Journal of Fisheries and Aquatic Sciences 40:259-266 (1983).

  Metabolic mineralization of ammonium by tubificid worms and chironomid larvae appears to be an important mechanism contributing to nitrogen regeneration from aerobic lake sediments. Mean weight (ash free dry weight; AFDW)-specific ammonium release rates ranged from 3 to 15 nmole NH_4 (mg AFDW)$^{-1}$ h^{-1} for animals collected at different times and temperatures from nearshore Lake Michigan sediments. Although mean rates of nitrogen release were similar for the two groups of benthic invertebrates, the patterns of release were different. Tubificids released nitrogen (ammonium plus primary amines) continuously, whereas chironomids released it in spurts several times per hour. Mean ammonium-release rates were generally constant with time after the animals were removed from food for both species. This suggests that ammonium regeneration for these benthic animals is primarily an endogenous process. Conversely, primary amine nitrogen release often decreased with time after food removal and may reflect either egestion of partially digested materials from the animals' guts or a decrease in the metabolic pool size of free amino acids. Based on previous measurements of phosphorus release, mean molar $NH_4:PO_4$ ratios in excreted materials were calculated to be 15:1 for chironomids and 35:1 for tubificids.

GL-019
GARDNER, W. S., and H. A. VANDERPLOEG. Microsample-filtering device for liquid chromatography or flow injection analysis. <u>Analytic Chemistry</u> 54:2129-2130 (1983).

A micro-filtering device was interfaced with a loop injector to filter small (1 mL) samples before liquid-chromatographic or flow-injection analysis. The device has an active filtering area of 3 mm^2 and an internal dead volume of 0.04 mL. The filter holder was designed for convenient filter changing between sample injections.

GL-020
Gerould, S., P. F. LANDRUM, and J. P. Giesy. Anthracene bioconcentration and biotransformation in chironomids: Effects of temperature and concentration. <u>Environmental Pollution (Series A)</u> 30:175-188 (1983).

Effects of temperature and anthracene concentration on uptake (K_u) and depuration (K_d) rate constants and bioconcentration factor (^{14}C-BCF) were determined for larvae of the midge <u>Chironomus riparius</u>. At constant temperature (25°C) the uptake rate constant estimated from 10 h and 30 h exposure and by the initial rates methods increased with concentration between 1.7 and 30.5 µg litre^{-1}. At constant concentration (22 µg litre^{-1}), the uptake rate constant was maximum at 25°C and less at 16° and 30°C. The apparent increase in depuration rate constant with concentration during 30 h exposure was not confirmed in experiments in which contaminated animals depurated in uncontaminated paper towel. The ^{14}C-BCF did not change as a function of temperature or anthracene concentration. BCF based on anthracene concentration was minimum at 25°C when biotransformation rate was highest, and was more than an order of magnitude lower than ^{14}C-BCF.

GL-021
GREAT LAKES ENVIRONMENTAL RESEARCH LABORATORY. Annual report for the Great Lakes Environmental Research Laboratory. Great Lakes Environmental Research Laboratory, Ann Arbor, 50 pp. (1982).

No abstract.

GL-022
GREAT LAKES ENVIRONMENTAL RESEARCH LABORATORY. Technical plan for the Great Lakes Environmental Research Laboratory. Great Lakes Environmental Research Laboratory, Ann Arbor, 77 pp. (1983).

No abstract.

GL-023
GREAT LAKES ENVIRONMENTAL RESEARCH LABORATORY, the University of Michigan, the University of Minnesota, Michigan State University, Argonne National Laboratory, and Oak Ridge National Laboratory. Fourth semiannual progress report to the Office of Marine Pollution Assessment: The cycling of toxic organic substances in the Great Lakes ecosystem. Great Lakes Environmental Research Laboratory, Ann Arbor, 63 pp. (1983).

No abstract.

GL-024
GREENE, G. M. Forecasting ice-cover freeze-up, growth, and breakup on the St. Marys River. NOAA-TM-ERL-GLERL-47 (PB83 262097), 79 pp. (1983).

A 10-year time series of meteorological variables, water temperatures, and ice observations was used to develop methods for the prediction of ice-cover formation, growth rates, and decay at five sites along the St. Marys River, the channel connecting Lake Superior and Lake Huron. A site-specific heat transfer coefficient and observed water temperatures at Sault Ste. Marie, Mich., can be used to predict ice-cover formation. Standard errors in the predictions at the five sites are 30- to 60-percent lower than the corresponding standard deviations of the observations. A simple Stefan relationship with an average standard error of 8 cm over the season can be used to simulate ice-cover growth. Unlike the ice formation prediction method, ice growth prediction is quite sensitive to the accuracy of the air temperature forecasts. No one method can be used to predict ice-cover breakup at all five sites. Breakup dates are most strongly correlated with the date at which water temperature rises above 0°C at Sault Ste. Marie. This date, however, can be less than 1 week prior to breakup at some sites or may occur after breakup. Maximum

ice-cover thickness in the river and maximum ice-cover extent on Lake Superior are both poor predictors of the breakup date.

GL-025
    GREENE, G. M., and F. Nelson. Performance of a frost hollow as a hemispherical thermal radiometer. Archives for Meteorology, Geophysics, and Bioclimatology, Series B 32:263-278 (1983).

    Radiant sky hemispheric temperature, snow-surface temperature, and thermal profiles within the snowpack were measured at night in a frost hollow in southeastern Michigan, U.S.A. Snow-surface temperatures remained 3° to 5°C colder than air temperatures at 3 m above the snow surface and 6° to 7°C colder than air temperatures at 18 m, the height of the hollow's rim above its floor. Due to suppression of turbulent heat transfer, the energy balance at the surface was dominated by net longwave radiation; energy involved in sensible heat transfer through the snow was equal to only about 10% of the incoming longwave radiation. Incoming longwave radiation can be expressed as a linear function of surface temperature by means of a regression equation, which yields a coefficient of determination of 0.75.

GL-026
    Haddock, J. D., P. F. LANDRUM, and J. T. Giesy. Extraction efficiency of anthracene from sediments. Analytic Chemistry 55:1197-1200 (1983).

    No abstract.

GL-027
    HAWLEY, N. Lake Michigan suspended sediment characteristics at Grand Haven, Michigan, 1979. NOAA-DR-ERL-GLERL-23 (PB83 222638), 7 pp. (1983).

    Suspended sediments collected on 4 different days in 1979 have been measured with a Quantimet image analyzer and identified by particle type. The data may be used to deduce changes in particle composition as a function of particle size, season of the year, and water depth.

GL-028
    HAWLEY, N. A numerical model of cohesive suspended sediment dynamics. NOAA-TM-ERL-GLERL-42 (PB83 207860), 44 pp. (1983).

    This report documents a one-dimensional finite-difference computer program which models cohesive suspended sediment dynamics in a shear flow. The model is based on Smulchowski's geometrical collision formulas. User-supplied empirical constants are necessary to determine the collision efficiency and aggregate shear strength. The model does not include biological or chemical processes, or lateral advection. At present the model is designed to reflect conditions in the Great Lakes, but by changing the boundary conditions it could be modified for other environments.

GL-029
    HAWLEY, N., R. L. CHAMBERS, and G. L. BELL. Grain-size distribution in Lake Michigan, 1977-81. NOAA-DR-ERL-GLERL-21 (PB83 194399), 13 pp. (1983).

    The grain-size distributions of suspended material collected from Lake Michigan were measured with a HIAC particle counter. The Lake Michigan samples appear to have relatively more large particles than do oceanic samples, but the difference may be due to differences in the instruments used to measure the particles.

GL-030
    Henderson-Sellers, B., M. J. McCORMICK, and D. SCAVIA. A comparison of the formulation for eddy diffusion in two one-dimensional stratification models. Applied Mathematical Modeling 7:212-215 (1983).

    Two models for thermal stratification based on turbulent diffusion concepts are analysed and compared. The models, by Henderson-Sellers and by McCormick and Scavia, are shown to be equivalent at large values of the Richardson number, R_i. At small R_i, the simpler model reverts to specification of the turbulent diffusion as a constant value. This simplification is also demonstrated to be a realistic approximation only at low wind speeds and for deep lakes. By comparison of these model types, a (previously empirically defined by McCormick and Scavia) parameter β is related conceptually to the lake depth, H.

GL-031
HINKEL, K. M. Ice-cover growth rates at nearshore locations in the Great Lakes. NOAA-TM-ERL-GLERL-44 (PB83 233049), 40 pp. (1983).

Ice thickness data from 32 nearshore locations around the Great Lakes were correlated to accumulated degree-days of frost over a 6- to 11-year period. A simple parastatistical model was used to compute ice-cover growth coefficients that reflect the relative impact of site-specific factors and processes on ice growth for each ice measurement site. In addition, two data sets were used to illustrate the inhibiting influence of snow on ice growth. Statistical parameters generated for each site and data set were used to summarize the degree of predictive accuracy. For 27 sites, a weighted R^2 value of 0.82 was achieved with an average standard error of estimate of 6.95 cm. As an additional test, the site-specific ice growth coefficients were applied to unpublished ice thickness data for the abnormally cold winters of 1977-78 and 1978-79. For these two seasons, the average standard error of estimate was 5.39 cm.

GL-032
International Joint Commission, International Great Lakes Technical Information Network Board, Hydrology Committee. Great Lakes hydrometeorological station directory. NOAA-DR-ERL-GLERL-22 (PB83 208124), 268 pp. (1983).

This report lists all hydrological stations located within the Great Lakes Basin and all meteorological stations located in or near the Great Lakes Basin deemed pertinent to the International Great Lakes Technical Information Network Board. The listing identifies each station by station number, station name, location, elevation, years of record, type, and availability of the data, operating agency, and acquisition agency. A standard table format was created and used throughout. All information presented was provided by various agencies within the United States and Canada. Stations were grouped by type and plotted to provide information on the spatial distribution of the various types of stations. The base map is of the entire Great Lakes and St. Lawrence River drainage basins and includes each Great Lakes subbasin.

GL-033
LANDRUM, P. F. The effect of co-contaminants on the bioavailability of polycyclic aromatic hydrocarbons to Pontoporeia hoyi. In Polynuclear Aromatic Hydrocarbons: Seventh International Symposium on Formation, Metabolism, and Measurement, M. W. Cooke and A. J. Dennis (eds.), Columbus, Ohio, October 26-28, 1982. Battelle Press, Columbus, Ohio, 731-743 (1982).

No abstract.

GL-034
LANDRUM, P. F., and D. SCAVIA. Influence of sediment on anthracene uptake, depuration, and biotransformation by the amphipod Hyalella azteca. Canadian Journal of Fisheries and Aquatic Sciences 40:298-305 (1983).

Uptake, depuration, and biotransformation rates of ^{14}C-anthracene were determined for Pontoporeia hoyi, the dominant benthic invertebrate in the Great Lakes, at 4°, 7°, 10°, and 15°C. The uptake rate constants for anthracene increased from 136 ± 22 h^{-1} (n = 4, $\overline{X}\pm1SD$) to 215 ± 45 h^{-1} (n = 4) over the temperature range studied and were seasonally dependent. The depuration rate constant at the apparent optimum temperature of 7°C was 0.015 h^{-1} for anthracene. The biotransformation ability of P. hoyi is low, and degradation of anthracene was undetectable even after exposures of 48 h. The bioconcentration factor can be predicted from the uptake and depuration kinetics to be approximately 16,800 at 4°C. These experiments imply that P. hoyi may be very important in food chain biomagnification of some toxic organics.

GL-035
Meadows, G. A., N. Schultz, H. Dannelongue, J. R. BENNETT, J. CAMPBELL, P. C. LIU, and D. J. SCHWAB. The response of the coastal boundary layer to winds and waves: Analysis of an experiment in Lake Erie. Proceedings, Third Workshop on Great Lakes Coastal Erosion and Sedimentation, Burlington, Ontario, November 1-2, 1982. National Research Council Canada and Associate Committee for Research on Shoreline Erosion and Sedimentation, Ottawa, Ontario, 51-54 (1982).

No abstract.

GL-036
NALEPA, T. F., W. S. GARDNER, and J. M. MALCZYK. Phosphorus release by three kinds of benthic invertebrates: Effects of substrate and water medium. Canadian Journal of Fisheries and Aquatic Sciences 40:810-813 (1983).

The effects of sand substrate (presence vs. absence) and type of water medium (distilled or lake) on phosphorus excretion rates of tubificids, chironmids, and the amphipod Pontoporeia hoyi were determined. In contrast to previous studies on respiration rates, the presence or absence of a substrate did not significantly affect the excretion rates of any of the three taxa. Realistic determinations of P excretion can thus be obtained without a substrate present; this simplifies the approach to such determinations. Excretion rates of tubificids and chironomids were not affected by the type of medium, but the excretion rate of P. hoyi was slightly (but significantly) higher in distilled water than in lake water.

GL-037
PICKETT, R. L., J. E. CAMPBELL, A. H. CLITES, and R. M. Partridge. Satellite-tracked current drifters in Lake Michigan. Journal of Great Lakes Research 9:106-108 (1983).

Satellite-tracked current drifters are being used to monitor near-surface currents in Lake Michigan. These drifters are now commercially available, and preliminary tests show their satellite-determined positions to be within 0.5 km. The drifters appear to be ideal for monitoring near-surface lake currents and testing hydrodynamic lake models.

GL-038
PINSAK, A. P., and G. K. Rodgers. Energy balance. In IFYGL--The International Field Year for the Great Lakes, E. J. Aubert and T. L. Richards (eds.), Great Lakes Environmental Research Laboratory, Ann Arbor, 169-197 (1981).

No abstract.

GL-039
QUIGLEY, M. A. Freshwater macroinvertebrates. Journal of the Water Pollution Control Federation 55:833-840 (1983).

No abstract.

GL-040
QUINN, F. H., and G. den Hertog. Evaporation synthesis. In IFYGL--The International Field Year for the Great Lakes, E. J. Aubert and T. L. Richards (eds.), Great Lakes Environmental Research Laboratory, Ann Arbor, 221-245 (1981).

No abstract.

GL-041
QUINN, F. H., and R. N. KELLEY. Great Lakes monthly hydrologic data. NOAA-DR-ERL-GLERL-26 (PB84 114545), 84 pp. (1983).

Accurate values of monthly hydrologic data are required for simulation, forecasting, and water resource studies of the Great Lakes and their basins. This report summarizes the monthly hydrologic data currently used by the Great Lakes Environmental Research Laboratory in their hydrologic and water resource studies of the Great Lakes. The data consist of precipitation, runoff, evaporation, connecting channel flows, diversions, beginning-of-month lake levels, and rates of change in storage.

GL-042
Reckhow, K. H., and S. C. CHAPRA. Engineering Approaches for Lake Management, Volume 1: Data Analysis and Empirical Modeling. Butterworth Publishers, Boston, 358 pp. (1983).

No abstract.

GL-043
   Richards, T. L., and E. J. AUBERT. The International Field Year for the Great Lakes--An introduction.
   In IFYGL--The International Field Year for the Great Lakes, E. J. Aubert and T. L. Richards (eds.),
   Great Lakes Environmental Research Laboratory, Ann Arbor, 1-14 (1981). (Published in 1983.)

   No abstract.

GL-044
   ROBBINS, J. A. Stratigraphic and dynamic effects of sediment reworking by Great Lakes zoobenthos.
   Hydrobiologia 92:611-622 (1982).

   Recent sediments of the North American Great Lakes are inhabited by numerous species of macrobenthos
which alter the physical and chemical properties of sediments and modify interface transport charac-
teristics. Distributions of such radionuclides as cesium--137, lead--210, and isotopes of plutonium
exhibit a zone of constant activity extending down from the sediment-water interface from 1 to 15 cm.
Recent studies have confirmed that radiometrically determined mixed depths are consistent with the ver-
tical distribution of oligochaete worms and the amphipod, Pontoporeia hoyi. Generally, 90% of the benthos
are contained within the radiometrically defined mixed zone. Where comparisons are possible, rates of
sediment reworking by 'conveyor belt' species are comparable to or exceed sedimentation rates. Systematic
variations in the mixed depth occur within depositional basins with greatest depths tending to be asso-
ciated with least consolidated, organically rich materials. A quantitative steady-state mixing model
accounts satisfactorily for observed radioactivity and heavy metal profiles. Bioturbation appears to be
an important process, limiting the resolution with which historical records of particle-associated con-
taminants may be reconstructed from sediment cores. As bioturbation serves to maintain contact of con-
taminated sediments with overlying water, this time may also characterize the long-term lake recovery for
contaminants removed by burial. As the time varies with location, a mean for an entire lake is not well
known, but is on the order of 20 years for Lake Huron.

GL-045
   Rumer, R. R., Jr., W. F. Bialas, F. H. QUINN, R. A. ASSEL, AND D. W. GASKILL. Niagara River ice boom:
   Effects on environment. Journal of Technical Topics in Civil Engineering 109:105-116 (1983).

   Two approaches are described for examining the possible effect of an ice boom on the air and water tem-
peratures. The first approach utilizes a mathematical model for the ice dissipation process incorporating
ice discharge from Lake Erie into the Niagara River. The model provides a useful framework for judging
the relative significance of in-lake ice melt and river ice discharge in terms of ice area reduction in
the lake. The second approach utilizes statistical testing of air and water temperature data to detect a
boom effect. Although the power of the test is limited by the size of the data set, it is concluded that
the ice boom has no significant effect on the air and water temperatures.

GL-046
   SAYLOR, J. H., J. R. BENNETT, F. M. Boyce, P. C. LIU, C. R. Murthy, R. L. PICKETT, and T. J. Simmons.
   Water movements. In IFYGL--The International Field Year for the Great Lakes, E. J. Aubert and T. L.
   Richards (eds.), Great Lakes Environmental Research Laboratory, Ann Arbor, 247-324 (1981).
   (Published in 1983.)

   No abstract.

GL-047
   SCAVIA, D., and W. S. GARDNER. Kinetics of nitrogen and phosphorus release in varying food supplies by
   Daphnia magna. Hydrobiologia 96:105-111 (1982).

   Rates of nitrogen and phosphorus release from individual Daphnia magna were determined by measuring
ammonia and soluble reactive phosphorus in successive 10-min incubations in small (0.05 ml) vessels after
the animals were removed from their food. Release rates of both nutrients were generally highest
initially and decreased with time after removal. The ratio of nitrogen to phosphorus released increased
with time after animals were removed from an artificial detritus/bacterial food; ratios were lower and
changed with time less for animals fed algae. These data suggest errors may be introduced by assumptions
of constant stoichiometry for nutrient release in varying environments.

GL-048

SCHWAB, D. J., and K. Hutter. Barotropic and baroclinic eigenmodes of Lake of Zurich and Lake of Lugano. Internal Report, Versuchsanstalt für Wasserbaur, Hydrologie und Glaziologie, Zurich, Switzerland, 118 pp. (1982).

Results of numerical finite difference solution for the barotropic and baroclinic eigenmodes for Lake of Zurich and Lake of Lugano are presented. Basic equations for barotropic modes are the (non-rotating) shallow water equations. Seiche periods and mode structures (amplitude distribution of surface elevation, normalized with a maximal value 100) are calculated by approximating Lake of Zurich and Lake of Lugano by a set of square grids. The baroclinic modes are calculated by using a two-layered-variable depth model. Seiche periods and mode structures are again calculated by dividing the lake domain into a system of grids, but the lake domains are now defined by the intersection of the thermocline depth with the bottom topography. The results are not further interpreted.

GL-049

SONZOGNI, W. C., W. Richardson, P. Rodgers, and T. J. Monteith. Chloride pollution of the Great Lakes. Journal Water Pollution Control Federation 55:513-521 (1983).

Chloride has long been used as an indicator of pollution in the Great Lakes, one of the largest and most valuable fresh-water resources in the world. Marked increases in chloride concentrations since the early 1900s, which are considered symptomatic of a variety of cultural impacts, were a major impetus for the multi-billion-dollar Great Lakes pollution abatement programs instituted during the 1970s. More recently, chloride and other conservative ions have been implicated as pollutants, based on their possible roles in changing the assemblages and distributions of algae and other organisms in the lakes. Current concern over chloride is exemplified by a recent conference held to cultivate a 5-year U.S. plan for Great Lakes research and development. Chloride discharges were identified as one of several major problems worthy of special attention. This paper summarizes current estimates of chloride inputs to the Great Lakes from various sources. It also evaluates changes that have occurred. Future chloride levels are projected with the aid of a mathematical model that treats the lakes as an integrated system. Management implications of current and future chloride inputs in the lakes are discussed. Particular attention is given to Lake Michigan, especially with regard to modeling its response to chloride inputs.

GL-050

Spacie, A., P. F. LANDRUM, and G. J. Leversee. Uptake, depuration, and biotransformation of anthracene and benzo(a)pyrene in bluegill sunfish. Ecotoxicology and Environmental Safety 7:330-341 (1983).

Bluegills (Lepomis macrochirus Raf.) were exposed to [^{14}C]anthracene or [^{14}C]benzo[a]pyrene (B[a]P) in water. Rates of uptake and biotransfomation within the fish were followed by ^{14}C counting and thin-layer and liquid chromatography. The initial uptake-rate coefficient for anthracene (K_U = 36 hr^{-1}) was found to be independent of exposure concentration. The presence of dissolved humics did not affect anthracene uptake, but did reduce the B[a]P uptake rate significantly. Biotransformation of the anthracene was constant at 0.22 nmol/g/hr, with approximately 92% of the residue unmetabolized at 4 hr. Uptake of B[a]P was linear (K_U = 49 hr^{-1}), although biotransformation increased from 0.044 to 0.088 nmol/g/hr between 1 and 2 hr of exposure. Only 11% of the B[a]P ^{14}C activity at 4 hr represented the parent compound. Although 6% of the anthracene was found in liver and gall bladder, 25% of the B[a]P was distributed in the two organs. Depuration rates were first order and yielded half-lives of 17 hr for anthracene and 67 hr for B[a]P. The estimated bioconcentration factors (BCF) for anthracene and B[a]P in whole fish (K_U/K_D) were 900 and 4900, respectively, for total ^{14}C activity, but only 675 and 490 for parent material. These BCFs were considerably lower than those predicted from the octanol-water partition coefficients because of biotransformation.

GL-051

Steinhart, C. E., L. J. Schierow, and W. C. SONZOGNI. An environmental quality index for the Great Lakes. Water Resources Research 18:1025-1031 (1982).

To facilitate communication on the environmental quality of lakes, particularly among policy makers and the general public, a new index for summarizing technical information is presented. The index is designed for the nearshore waters of the North American Great Lakes, but the concept is applicable to other temperate lakes with relatively good water quality. The index is based on nine physical (P), chemical (C), biological (B), and toxic substance (T) variables. Raw data are converted to subindex values by mathematically defined functions based on national or international objectives. Subindex values are multiplied by weighting factors and added to yield a final score ranging from 0, worst quality, to 100, highest quality. Letters with subscripts following the index score indicate the types and numbers of variables whose values

are equal to or worse than the objective—e.g., 70 C_1P_1 indicates that one chemical and one physical variable exceeded the objective. For 18 nearshore locations in the Great Lakes, index scores ranged from 98 at two stations in Lake Superior to 30 $C_2P_1B_2T_3$ off Point Mouillee in Lake Erie. If properly utilized, the index should be a useful tool to help managers evaluate the response of the Great Lakes to the multi-billion dollar cleanup efforts conducted during the 1970's.

GL-052
TARAPCHAK, S. J. Soluble reactive phosphorus measurements in lake water: Evidence of molybdate-enhanced hydrolysis. Journal of Environmental Quality 12:105-108 (1983).

Measurements of orthophosphate (PO_4-P) concentrations in natural waters obtained by molybdenum blue methodology are based on the assumption that molybdate complexes only with PO_4-P (in the absence of arsenate and silicate interference) to form the reductant-sensitive complex 12-molybdophosphoric acid (12-MPA). The hypothesis that molybdate causes or accelerates PO_4-P release from bound sources or forms reductant-sensitive complexes with organic compounds (organic-PO_4-Mo) was tested by exposing filtered Lake Michigan water to acid, acid plus molybdate simultaneously, and molybdate, respectively, before measuring PO_4-P by the Chamberlain-Shapiro extraction method. Molybdate not only accelerates hydrolysis in the presence of acid, but also either causes hydrolysis or forms organic-PO_4-Mo before samples are acidified. Although the relative amounts of 12-MPA and organic-PO_4-Mo formed in lake water cannot be assessed quantitatively, a major fraction of the blue color formed during routine analysis by this or by similar methods apparently is not the product of acid hydrolysis, but may also be due to reduction of organic-PO_4-Mo. Future developments in molybdenum blue methodology aimed at minimizing hydrolysis must consider the sequence of reagent additions and molybdate, as well as acid, contact times.

GL-053
TARAPCHAK, S. J., S. M. BIGELOW, and C. RUBITSCHUN. Soluble reactive phosphorus measurements in Lake Michigan: Filtration artifacts. Journal of Great Lakes Research 8:550-557 (1982).

Tests based on variations in vacuum pressure, volume of sample filtered, and filter pore size demonstrate that filtration artifacts seriously bias estimates of soluble reactive phosphorus (SRP) in water from Lake Michigan. Variations in vacuum pressure and filter pore size can bias estimates by approximately 100%, and variations in sample volume alone can produce nearly a twofold difference in SRP values. These biases are caused by differences in the relative amounts of molybdate-reactive PO_4-P released from particulate material and by the retention of P-containing "particles" by filters as pores clog with debris, and are partially responsible for method-specific differences in SRP estimation. Vacuum pressures <300 mm Hg, small sample volumes (<100 mL), and filters of the same type and pore size should be used for routine SRP estimation.

GL-054
TARAPCHAK, S. J., R. L. CHAMBERS, and S. M. BIGELOW. Soluble reactive phosphorus measurements in Lake Michigan: Causes of method-specific differences. Journal of Great Lakes Research 8:700-710 (1982).

Method-specific differences in soluble reactive phosphorus (SRP) determinations are thought to be caused in part by differences in acid strengths and exposure times. This premise was tested by comparing SRP concentrations measured in water from Lake Michigan and the Grand River by three methods differing in acid strength, exposure time, and molybdate concentration. Although longer exposure times often result in higher SRP values, more PO_4-P can be released from bound sources in lake water with 0.16 N HCl than with 0.4 N HCl. Method-specific differences in SRP values, therefore, rarely are proportional to differences in acid strength or exposure time and will vary with changes in the chemical composition of the SRP pool.

GL-055
TARAPCHAK, S. J., D. R. SLAVENS, M. A. QUIGLEY, and J. S. Tarapchak. Silicon contamination in diatom nutrient enrichment experiments. Canadian Journal of Fisheries and Aquatic Sciences 40:657-664 (1983).

Large amounts of biologically available silicon (Si) were released into solution from the walls of Pyrex glass reagent bottles and Erlenmeyer flasks during nutrient bioassay experiments using Lake Michigan water. Photosynthetic rates in short-term (4-7 h) incubations and diatom growth rates and maximum yields in long-term incubations (~7 d) were affected by these extraneous Si supplies. The results of conventional nutrient enrichment bioassays performed in low-Si environments can be seriously biased unless Si contamination from glass incubation containers is avoided.

GL-056
  VANDERPLOEG, H. A., and D. SCAVIA. Misconceptions about estimating prey preference. Canadian Journal of Fisheries and Aquatic Sciences 40:248-250 (1983).

No abstract.

NS-001
Arnold, R. T., W. D. RUST, and D. W. BURGESS. A study of severe storm electricity via storm intercept. Technical Memorandum PARGUM 82-02, University of Mississippi, University, Mississippi (1982).

No abstract.

NS-002
BRANDES, E. A. Rainfall measurement with radar. Proceedings, NEXRAD Doppler Radar Symposium/Workshop, P. Ray (Ed.), September 22-24 1983, Norman, Oklahoma, 144-163 (1983).

Doppler velocity measurements will add qualitative information about precipitation areas, but will not improve the accuracy of point measurements. The value of the reflectivity data will improve slightly with the narrower beam of the NEXRAD system. Calibration with rain gages remains the only way of improving radar measurements, unless polarization measurements are developed and tested.

NS-003
BROWN, R. A., and S. P. NELSON. Multiple Doppler radar derived vertical velocities in thundertsorms. Part II - Maximizing areal extent of vertical velocities. NOAA Technical Memorandum, ERL NSSL-94, National Severe Storms Laboratory, Norman, Oklahoma, 11-21 (1982).

Vertical velocities are deduced from multiple Doppler radar measurements through vertical integration of the three-dimensional mass continuity equation. However, vertical velocity information is lost in those vertical columns that do not have a continuity of Doppler radar data. This situation becomes critical in studies of the more severe thunderstorms where the very updrafts that the researcher is attempting to study are the cause of data gaps (e.g., weak echo regions). Problems also arise when multiple Doppler radar data are not collected to storm top. This paper explores some techniques that can be used to extract the greatest amount of vertical velocity information from these problem data sets.

NS-004
BROWN, R. A., and V. T. WOOD. Single Doppler velocity signatures as indicators of storm severity. Proceedings, NEXRAD Doppler Radar Symposium/Workshop, P. Ray (Ed.), September 22-24, 1983, Norman, Oklahoma, 164-183 (1983).

Doppler radar signatures of severe storms can be modeled by divergence and vortex models. Application of these models to storm data show good similarity and ease of recognition in real time. However, if NEXRAD systems are to identify vortex signatures automatically, preprocessing of the data is needed to remove range and velocity ambiguities.

NS-005
Connor, H. W., D. Gromala, and D. W. BURGESS. Retrofitting houses for wind resistance. Report No. OU-155-239, University of Oklahoma, Norman, Oklahoma (1983).

No abstract.

NS-006
DAVIES-JONES, R. P. An accurate theoretical approximation for adiabatic condensation temperature. Monthly Weather Review III: 1119-1121 (1983).

A theoretical approximation for condensation temperature is obtained. The approximate solution lies within 0.01K of the corresponding iterative solution for dewpoint depressions up to 40K. This approximation error is less than the uncertainty resulting from use of an empirical formula for saturation vapor pressure and the assumption that c is constant for dry air.

NS-007
Donaldson, R. J., and D. W. BURGESS. Results of the joint Doppler operational project. Proceedings of the NEXRAD/CIMMS Symposium on Doppler Radar, September 22-24, 1982, Norman, Oklahoma, 102-123 (1982).

The JDOP tests proved that Doppler radar can save lives and protect property through improved warnings of tornadoes and hail. The most important warning criteria involves tracking and extrapolating storm centers, and the early detection of mesocyclones and mid-level reflectivity cores. New criteria to further improve identification of events will require mapping storm structure and pattern recognition.

NS-008

DOVIAK, R. J. A survey of radar rain measurement techniques. <u>Journal</u> <u>of</u> <u>Climate</u> <u>and</u> <u>Applied</u> <u>Meteorology</u> 22: 832-849 (1983).

Several methods used to estimate rainfall rate R are surveyed. The distribution N(D) of dropsizes is of central importance in determining the reflectivity factor Z, attenuation rate K, and R. With single parameter measurement techniques either of the remotely sensed parameters Z or K can be used to estimate R when gross assumptions on N(D) can be made. If N(D) can be described by a two parameter distribution, dual measurement techniques can better estimate R without invoking these coarse assumptions. A review is made of three techniques whereby two variables might be measured: (1) dual wavelength in which Z and K are remotely measured, (2) dual polarization in which reflectivity is measured with two orthogonal polarizations and (3) rain gage radar combinations whereby in situ point measurements of R and radar measurement of Z or R are combined to obtain a better assessment of rain over areas between gages.

NS-009

DOVIAK, R. J., and D. S. ZRNIC'. Fresnel zone considerations for reflection and scatter from refractive index irregularities. Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada, 111-117 (1983).

Several different echoing mechanisms have been proposed to explain VHF/UHF scatter from clear air. Gage and Balsley (1980) suggest three: (1) anisotropic scatter, (2) Fresnel reflection, and (3) Fresnel scatter in order to account for the spatial (angle and range) and temporal dependence of the echoes. Rottger (1980) proposes the term "diffuse reflection" to describe the echoing mechanism when both scatter and reflection are simultaneously present. Scatter from anisotropic irregularities has, for many years, been thought to be principally responsible for microwave echoes from the clear air. Existing formulations assume that the correlation length of refractive index irregularities, generated by turbulence, are small compared to the Fresnel length. But there is experimental evidence that the contrary may be true. This paper extends the existing formulations for the case where the Fresnel zone radius is comparable to or larger than the correlation length. Fresnel reflection (also termed partial or specular reflection) is caused by vertical gradients of refractive index that have horizontal dimensions large compared to the first Fresnel zone and are long-lived. In this case, the vertical profile of refractive index variations may be best described by a deterministic function especially if there are a few locations where refractive index departs significantly from an otherwise smooth profile and persists. On the other hand, the solutions derived in this paper suggest that when the horizontal correlation length for random anisotropic irregularities is comparable to or larger than the Fresnel zone radius, the echoing mechanism might also be considered reflective. The only feature that could then distinguish Fresnel reflection from anisotropic scatter is temporal behavior. Rottger (1980) has found that Doppler spectra have simultaneously exhibited two spectra of distinctly different widths suggesting both Fresnel reflection and scatter or "reflection" from random refractive index irregularities. Although Gage and Balsley (1980) suggest that a statistical approach can be adopted for Fresnel scattering, they do not use one to show that reflection coefficient is proportional to the square of transmitted pulse width. Using statistical descriptions of the refractive index irregularities, we find the dependence of echo power on range resolution and give conditions for which dependence is either linear or square. We also derive the spectral sampling function and demonstrate that, for resolution volumes in the antenna's far field, this function is independent of the location of the resolution volume in real space

NS-010

DOVIAK, R. J., R. M. RABIN, and A. J. KOSCIELNY. Doppler weather radar for profiling and mapping winds in the prestorm environment. IEEE <u>Transactions</u> on Geosciences and Remote Sensing, GE-21, 25-33 (1983).

Doppler weather radars have the potential to profile winds throughout the troposphere for all weather conditions. They require 1/40th the transmitter power x antenna aperture area product needed by VHF radars. Two modes of wind measurements are suggested: (1) wind profiling to obtain the vertical distribution of horizontal and vertical motions of air, and (2) mapping winds, divergence and deformation in the prestorm convective boundary layer.

NS-011

Foster, M. P., J. C. Pflaum, and S. P. NELSON. The sensitivity of hailstone growth to variations in microphysical parameters. Preprints, Conference on Cloud Physics, November 15-18, 1982, Chicago. American Meteorological Society, Boston, 438-441 (1982).

Within the computer-reconstructed three-dimensional wind field of an actual thunderstorm, as deduced from triple-Doppler radar analyses, the sensitivity of hailstone growth to variations in cloud droplet spectra were examined. Smaller cloud droplet radii promoted faster freezing of accreted droplets and hence low density growth. In some cases the low density growth allowed hailstones to ascend more quickly in the updraft. This, coupled with the natural wind shears in the storm, caused these hailstones to follow markedly different trajectories than modeled hailstones constrained to grow at a density of 0.9 gcm^{-3} and in some cases to accrete five fold more mass. The computational behavior of growing hailstones and addressed such things as variable collection efficiencies, variable densities of accretion, the soaking of porous ice during wet growth and the freezing of spongy hailstones. Through the use of this scheme, it was possible to reconstruct layered growth structures very similar to those observed in natural hailstones. Examples of such reconstructions will be shown. Finally, comparison of the current model to models which neglected the microphysical details of hail growth, suggest that such simplifications can no longer be considered viable approximations in all circumstances.

NS-012

Fred, D., and E. KESSLER. Precipitation variability in Oklahoma. CIMMS Report and Contribution No. 41, Cooperative Institute for Mesoscale Meteorological Studies, Norman, Oklahoma (1983).

Temporal and spatial variability of rainfall is revealed by rain gage records from Crop Reporting Districts in Oklahoma (approximately one gage/364 mi^2) and from a rain gage network around Chickasha, Oklahoma, maintained by the United States Department of Agriculture (aproximately one gage/8 mi^2). During the period 1962-1977 the average difference between extrema of annual totals over the Chickasha network (1300 mi^2) is about 15", or about 53 percent of the annual average over that area, with local differences as much as 13" within 4 miles. During the same period, annual spatial averages in the Chickasha network varied from 20.2" to 40.6". Since the spatial standard deviation of annual totals in the Chickasha network is about 3.0", 10 rain gages sufice to depict the spatial average there with a standard error of about 1.0". Of course, small scale details would not be revealed without rain gages commensurately spaced. On the Chickasha network, gage spacing of 5 miles or less must be utilized to show detailed spatial variations of 3.0" or less. Over Oklahoma Crop Reporting Districts (CRD's), whose average size is about 7500 mi^2, the range of individual annual station totals is typically about 56 percent of the annual average to which they contribute. The range of average annual values from year to year is similarly large; reported precipitation over the Panhandle District, driest of the nine CRD's, varied from 12.6" to 25.2", while over the wettest (southeast) CRD the variation was from 27.5" to 69.4". The average rainfall in CRD's is accurately reported from year to year by the existing regular reporting gages; however, their number is too small — by a factor of 15 — to show spatial variations of annual totals within the CRD's to an accuracy of 3" or less. Radar and satellite data represent other approaches to depicting such variability in rainfall. The study highlights the inadequacy of average rainfall values as a descriptor when the variance is large, especially when the variance is prominent on scales smaller than the sampling process. A computer program to map daily events on the Chickasha network, developed during this study, remains available for research used at the Oklahoma Climatological Survey, University of Oklahoma, and National Severe Storms Laboratory.

NS-013

KESSLER, E. Mesocyclone passes over NSSL surface station. Bulletin American Meteorological Society 63 (12): 1380-1386 (1982).

An apparent mesocyclone passed directly over a surface station that was equipped with both digital and strip chart recorders near Criner, Oklahoma. Peak gusts were 18 m s^{-1} (35 kt): within 3 minutes the surface wind changed from strong southeasterly to strong westerly. The pressure dropped 5 mb in 52 minutes and recovered 4 mb in 6 minutes. There was only a trace of precipitation. The wind system was probably an inertial remnant of circulation formed with a thunderstorm whose peak intensity occurred about three hours before the cyclone was observed.

NS-014

KOSCIELNY, A. J., and R. J. DOVIAK. An evaluation of the accuracy of some radar wind profiling techniques. Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada, 530-535 (1983).

Three techniques, commonly used to retrieve the three wind components from measurements of radial velocity made by monostatic Doppler radar, are triple split beam, azimuthal scanning (VAD), and elevation scanning (VED). An assumption of time invariance and horizontal spatial uniformity is usually made to retrieve the wind components from the radial velocities. These estimated wind components contain a variance error arising from uncertainty in the radial velocity measurements and a bias error related to nonuniformity of the wind field. The variance error can be evaluated for these scanning geometries if the radial velocity uncertainty is known; the bias error due to nonuniform wind can be approximately evaluated in terms of first spatial derivatives of the wind field. For simultaneous measurement of the three components, the total error is a function of the elevation angle for triple beam and VAD techniques and of the elevation interval for the VED, and can be computed for typical magnitudes of the radial velocity uncertainty and the first order wind derivatives.

NS-015
    LEE, J. T.. Use of Doppler radar to detect weather hazards such as turbulence, wind shear, and gust fronts. Digest, Volume I of the 1983 International Geoscience and Remote Sensing Symposium (IGARSS '83), Aug. 31 - Sept. 2, 1983. San Francisco, CA. Sec. WP-5. pp 2.1-2.7. (1983).

Doppler weather radar has advanced ability to pinpoint storm-related weather hazards to aircraft operations. Modern concepts of the internal structure of convective thunderstorms are developing mainly from multiple Doppler radar observations. In combination of two or more, these radars now provide detailed portrayals of (1) the precipitation-traced airflow in and beneath storm clouds, and (2) the ambient air motions that feed storm systems. Furthermore, single Doppler radar and applications have been extended to include practical methods for supplying virtually continuous profiles of the horizontal winds at various altitudes. Thus, this new tool has emerged as the salient means for probing the lower atmosphere, even in optically clear air. Doppler radar data have been collected and analyzed in a joint investigative effort by Federal Aviation Administration, National Aeronautics and Space Administration, United States Air Force, National Weather Service, and the National Severe Storms Laboratory. Comparisons between in situ measurements by aircraft, a 444 m meteorologically-instrumented tall tower, and Doppler radar data are presented. Mesocyclones, for example, can be detected to over 250 km while tornadoes are seen to about 150 km. Wind shear, turbulence, and gust fronts are also observable. These studies show the potential capabilities of Doppler radar in the National Air Space System.

NS-016
    MACGORMAN, D. R., W. L. TAYLOR, and A. A. Few. Some spatial and temporal relationships between lightning and storm structure and evolution. Preprints, International Aerospace & Ground Conference on Lightning and Static Electricity, Ft. Worth, Texas (1983).

We have used a number of systems to study relationships between lightning and other storm parameters. Since April 1981, we have operated a system for locating cloud-to-ground lightning strike points in Oklahoma. The system contains four remote stations, each of which determines azimuths to lightning strikes and transmits the data to a central site. We have also used acoustic and VHF techniques to map lightning flashes inside three storms for which S-band radar data are available, one in Colorado and two in Oklahoma. The acoustic mapping technique used in Colorado, determines the direction of arrival of a thunder impulse at an array of microphones and traces this ray back through the atmosphere to a range derived from the measured propagation time of the impulse. The VHF mapping technique used in Oklahoma, determines the direction angle from which a VHF impulse in the 30-80 MHz band arrives at each of two antenna arrays and triangulates from the two arrays to locate the source of the impulse. Only radar reflectivity data are available for the Oklahoma storms. Several characteristics of the reconstructed lightning have been relatively constant in all three storms: (1) The structure of individual flashes is usually predominately horizontal and can have a horizontal extent of tens of kilometers. (2) Most lightning structure inside the storm is at a height above the 0°C isotherm. (3) Lightning is not equally probable at all heights in a storm, but tends to occur in one or two layers, each a few kilometers thick. (4) The reconstructed lightning tends to occur near cores of high reflectivity (>45 dBZ), but often connects with regions of relatively weak reflectivity. (5) It also tends to occur in regions that are downstream from reflectivity and updraft cores. Furthermore, in Oklahoma summer storms, the fraction of cloud-to-ground flashes that lower positive, instead of the usual negative, charge ranges diurnally from 0.03 to 013 and peaks a couple of hours later in the evening than the total number of ground flashes. This indicates that, while the diurnal variations in convective growth of clouds is important for the production of both positive and negative ground flashes, the dissipating and late mature stages of summer storms are more conducive to positive flashes than earlier stages. There have been additional characteristics observed for which we have analyzed suitable data on only one day. In the one case where dual Doppler vertical velocity estimates were available, lightning tended to occur in regions of weak updraft (<10 m s^{-1}), often near regions of weak downdraft. We also examined variations in cloud-to-ground flash rates on a day when several tornadoes were observed. There was no obvious minimum in the ground flash rate of the storm as a whole during the time tornadoes were observed,

although the average number of strokes per flash increased after the tornadic stage ended and the fraction of flashes that lowered positive charge was generally larger before and during tornadoes. Within 10 km of the mesocyclone center, however, ground flash rates were lower before and during tornadoes and increased after the tornadic stage of the storm ended.

NS-017
   Mahapatra, P. R., and D. S. ZRNIC'. Scan rates of Next Generation Weather Radar. Digest, Volume I, of the 1983 International Geoscience and Remote Sensing Symposium (IGARSS '83), August 31 - September 2, 1983. San Francisco, CA. Sec. WP-5, pp 3.1-3.6. (1983).

The next generation weather radar (NEXRAD), which is a Doppler radar intended to replace the current chain of reflectivity-only radars, is at a stage of advanced specification and preliminary design. The multiservice nature of NEXRAD operation necessitates a careful balancing of system parameters. From the point of view of scan strategy, the requirements of the Federal Aviation Administration (FAA) are the most demanding. In the face of growing evidence that atmospheric convections are an important factor in air disasters, delays, inefficient operation and passenger discomfort, the FAA wishes to minimize the probability of missing the detection of even the smallest and most transient of convective phenomena that may be hazardous to or adversely affect, aviation. This calls for observation at a large number of scan levels within as small a cycle time as possible. However, increasing the scan speed beyond a certain limit significantly compromises the accuracy of Doppler spectral moment estimation. Studies have been conducted at National Severe Storms Laboratory (NSSL) to determine a suitable scan rate for the NEXRAD. In particular, it is sought to determine whether the 5-minute progressive scan cycle suggested for NEXRAD would be adequate for aviation weather surveillance. The proposed paper outlines the methodology and results of this study. Doppler radar data collected at NSSL during the Spring Programs of 1980 and 1981 are used as the data base for the study. Attention is focused on several major storm events and the significant features within these storms are examined to determine the shortest lifetimes and fastest rates of change which would, in turn, decide the slowest acceptable scan rate. Two approaches are used to determine the lifetimes of features. The first method is qualitative and is based on visual interpretation of time sequences of photographs of the Doppler moment fields of the storms taken off NSSL's full-color PPI displays. The second method is quantitative, involving the computation of the correlation between storm features and their evolutionary forms at a later time. The rate of decay of the correlation coefficient as a function of the elapsed time is an indicator of the speed of change of a particular feature. The computer-based correlation procedure and the interpretation of results involve many finer aspects which shall be brought out in the proposed paper. Both the methods of lifetime study utilize all the three Doppler moments: reflectivity, radial velocity and spectrum width. The study has shown that most of the significant features have lifetimes well in excess of the proposed NEXRAD scan cycle time. In some cases, there is marked difference between the rates of decay of correlation between different spectral moments of the same feature. In such cases, the lifetimes of the slowest-varying moment is of importance, since the NEXRAD will have the facility of monitoring all three moments simultaneously. The overall finding from this study is that a five-minute progressive scanning strategy seems to be adequate for the surveillance of weather phenomena hazardous to aviation. One limitation of the study is that extremely fast microbursts have not been explicitly encountered in any of the storms. The importance of a larger data base is emphasized in this connection.

NS-018
   Mahapatra, P. R., and D. S. ZRNIC'. Scanning strategies for Next Generation Weather Radars. Final Report DOT/FAA/RD-82/69, (1982).

This report presents the methodology and results of a study to estimate the lifetimes of significant features in typical storm phenomena. These results are expected to help in deciding the scan strategy of NEXRAD radars. In particular, the question of the adequacy of a 5-minute information update rate for NEXRAD in its aviation weather surveillance role has been addressed. Two methods are used for the lifetime study: photo-interpretive and computer-based correlation. The basis and program steps of the correlation method are discussed. Several storms are studied using both methods. It is found that the storms studied contain no feature that might have been missed by a 5-minute scan cycle provided that data from all the three-moment fields (reflectivity, radial velocity, and Doppler spectrum width) at several elevations are utilized in the detection of hazardous phenomena.

NS-019
   Mahapatra, P. R., D. S. ZRNIC', and R. J. DOVIAK. Optimum siting of NEXRAD to detect hazardous weather at airports. Journal of Aircraft 20: 363-371 (1983).

The Federal Aviation Administration has been concerned for some time about the number of aircraft accidents during terminal flight in which weather has been identified as the cause or a contributing

factor. The next generation weather radar (NEXRAD), for which final specifications are being worked out on a multi-service basis, offers the possibility of dedicated and detailed surveillance of hazardous weather in the terminal airspace. This paper outlines considerations for choosing a site for a NEXRAD intallation to fulfill this role in an optimum manner. It is shown that the detection of low level shear without precipitation imposes the most severe constraints on NEXRAD siting. Three general siting areas are considered: (1) within the airport area, (2) within the terminal area, but outside the airport area, (3) outside the terminal area. When a single NEXRAD radar must cover all hazardous phenomena over the terminal area, siting within the airport area appears to be the best choice. Under certin conditions, a case exists for siting the NEXRAD outside the terminal area.

NS-020
  Mazur, V., and R. J. DOVIAK. Radar cross section of a lightning element modeled as a plasma cyclinder. Radio Science 18: 381-390 (1983).

  The radar cross section of a lightning element modeled as a finite length plasma cylinder at an oblique angle of incidence is offered. The model is based on the exact solution of Maxwell's equations for a dielectric cyclinder of infinite length. Assumptions are made about reflection and transmission at joints between neighboring lightning elements. The proposed model is valid for cylinders with radii that are a small fraction of wavelength.

NS-021
  MCGINLEY, J. A diagnosis of alpine lee cyclogenesis. Monthly Weather Review 110 (9), 1271-1287 (1982).

  Diagnostic analyses of two cases of lee cyclogenesis in the Alps region are presented. Data used consisted of routinely available rawinsonde, satellite and aircraft data. The analysis employed a three-stage variational objective scheme which allowea assimilation of satellite retrieved temperatures, imposition of a weak geostrophic constraint consistent with quasi-geostrophic flow, and a method to satisfy continuity while combining kinematic and dynamic estimates of vertical motion. Evolution of vorticity, vertical motion, and energy are computed along with frontogenesis and Q-vectors (Hoskins et al., 1978) as diagnostic tools. The analyses indicate that lee cyclogenesis is a multistage process involving interaction between the flow and terrain. The developing cyclone passes through three stages: a shallow, terrain-induced barotropic phase, a rapid devlopment phase where barotropic and baroclinic processes act in concert, and a phase where the mature storm is dominated by baroclinic processes. From a quasi geostrophic point of view the most important process associated with mountains is the increase in strength of a baroclinic zone as it passes over the mountain range. The secondary flow responds by producing upward vertical motion in the lee of the mountain at middle levels, superimposed over low-level descending air on its slope. The stretching thus realized rapidly increases vorticity.

NS-022
  NELSON, S. P. Multiple Doppler radar derived vertical velocities in thunderstorms. Part I - Error analysis and solution techniques. NOAA Technical Memorandum ERL NSSL-94, National Severe Storms Laboratory, Norman, Oklahoma, 1-8 (1982).

  A detailed error analysis is performed on the problems associated with using multiple Doppler radar data and the continuity equation to solve for the vertical component of motion in deep convective storms. The errors considered are those due to either incorrect boundary values or errors encountered in integrating the horizontal divergence with height. Data show that errors in the integrated horizontal divergence are much larger than previously thought--indicating the previously ignored effects of bias values may be an important error source. A simple vertical velocity adjustment technique is presented which yields fairly accurate results under most conditions. In the unusual case, though, of reinforcing bias errors (e.g., excessive convergence in low levels capped by excessive divergence) the unadjusted profile obtained by downward integration yeilds better results at most levels than the adjusted profile. The effects of boundary errors on both adjusted and unadjusted vertical velocity profiles also are examined in detail.

NS-023
  NELSON, S. P. The influence of storm flow structure on hail growth. Journal of Atmospheric Sciences 40 (8): 1965-1983 (1983).

  Data from two supercell storms and a numerical model are used to identify storm flow structures that are important to hail growth. The maximum updrafts in the storms studied are sufficiently strong (50 $m\ s^{-1}$) that embryos are carried ift before much growth can occur. The critical flow factor is a broad

region of moderate updraft so that the hailstones can remain balanced in the prime growth regions. It is shown that even an abundant amount of embryos exist, some storms will not produce hail because of their lack of this suitable growth area. These results are extended to explain the observed radar characteristics of the most severe hailstorms that occur in Central Oklahoma. These storms display long pendant echoes and large bounded weak echo regions which are presumably associated with large updraft areas. An example is presented of a non-tornadic hailstorm that produced up to 75 mm diameter hail and a hailswath that was 300 km long and up to 40 km wide. The structure of this storm is contrasted to that of a severe tornadic storm that was not a prolific hail producer. Since measurements of storm kinematics are within the capability of existing technology, this suggests a powerful method for real-time identification of severe hailstorms.

NS-024
RABIN, R. M. Radar reflectivity in the clear boundary layer and its relation to surface fluxes. Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada, 646-649 (1983).

Doppler derived wind fields may diagnose prestorm environments, and refractive index fluctuations may provide information on the vertical fluxes of heat and moisture from the earth's surface. This paper reviews the relationship of radar reflectivity in clear air to the structure constants for potential temperature (C_θ^2), water vapor (C_q^2) and covariance of temperature and water vapor ($C_{\theta q}^2$) in the inertial subrange. Since experimental evidence shows these structure constants to be functions of inversion height, surface flux of heat and moisture, and height within the mixed layer, radar reflectivity should be directly related to these factors as well. For example, radar could be combined with direct measurements of net radiation to remotely measure heating rates and evaporation into the boundary layer. Radar reflectivity in relation to fluxes and height above the ground has been tested with NSSL's 10 cm radar and tall tower instrumentation. The change of reflectivity with height appears close to that expected in the lower part of the mixed layer. However, unlike observations in marine environments, no peak was detected near the top of the layer. Also, the measured radar reflectivity is much higher than expected from the estimated fluxes.

NS-025
RABIN, R. M. Single Doppler radar observations prior to thunderstorm development. Proceedings of the NEXRAD/CIMMS Symposium on Doppler Radar, Norman, Oklahoma, September 22-24, 1982, 198-214 (1982).

The VAD technique offers additional information about localized convergence in the boundary layer leading to storm development. It may be possible to monitor changes in the vertical air velocity by analyzing the divergence measurements made at different altitudes.

NS-026
RAY, P., J. Klemp, R. Wilhelmson, and K. JOHNSON. Testing of multiple-Doppler analysis procedures from the synthesis of simulated radar scans. Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada, 547-552 (1983).

Errors in wind fields derived from multiple-Doppler radar observations have been previously studied both theoretically and through grid point data supplied by model simulations. Here, radar data are recreated by sampling known fields, one model-produced and one from a previous multiple-Doppler analysis. The effects of several analysis assumptions are assessed by comparing the synthesized fields with the grid point values of the sampled storms. The effects resulting from uncertainties in advection, terminal velocity (hail), and boundary conditions are assessed. Comparisons are made between theoretical estimates of uncertainty resulting from radar deployment with respect to the analysis domain and actual error variance reductions.

NS-027
RUST, W. D., W. L. TAYLOR, D. R. MACGORMAN, R. Arnold, S. Goodman, and V. Mazur. Storm electricity research in Oklahoma: An overview. Preprints, International Aerospace & Ground Conference on Lightning and Static Electricity, Ft. Worth, Texas, 6/21-23/83 (1983).

In 1978 we began coordinated measurements of the electricity, kinematics, and precipitation associated with the large and often severe thunderstorms that form over the Great Plains of the United States. This research effort has incorporated cooperative studies with several groups, including universities and other U.S. Government agencies. Instrumentation that has been used includes: electric field change sensors, a dual-station VHF lightning mapping system, a four-station lightning ground strike locator, a mobile laboratory, two 10-cm wavelength Doppler radars, a 23-cm wavelength radar for lightning location,

electric field mills, optical transient detectors, a network of corona probes, and TV and film recording systems. Evidence that interrelationships do exist between electrical activity and storm development can be seen in the results to date. Examples from case studies of a single storm or system include: (1) The flashing rate in a squall line storm grossly followed the trends in the maximum Doppler-derived updraft velocity. (2) As a cell in a squall line developed and the flash rate increased, discharges that had large horizontal extents occurred, but the majority were short ones (i.e., 20 km). As the cell dissipated and decreased in radar reflectivity, the long flashes dominated the lightning activity. (3) VHF source locations within a non-tornadic, but severe, storm were common around the mesocyclone. Examples seen in several isolated storms or squall lines include: (1) Lightning tends to be near the edge of precipitation in the cores of developing cells. (2) VHF sources tend to occur in the vicinity of strong wind shear associated with the updraft. (3) Both the horizontal and vertical extent of flashes are quite variable; horizontal extents of tens of kilometers are common and several flashes in excess of 100 km have been observed. (4) Lightning within the storm tends to propagate at speeds of about 100 km/s but often between intervals of propagation is essentially stationary for tens of milliseconds. (5) The percentage of CG flashes that lower positive charge (+CG) to ground tend to cluster in time and can dominate the CG activity during some periods. These +CG flashes do occur during the mature and dissipating stages of severe storms and can emanate from the downshear anvil well away from the main core. (6) Positive CG flashes are often observed in the back side and low reflectivity regions of squall lines. (7) We also have learned that +CG flashes are not "triggered" flashes but are naturally-occurring and downward propagating. They tend to be single stroke and have field changes indicative of continuing current and rise times similar to -CG flashes, including an initial slow ramp followed by a very fast transition to peak in the return stroke. These flashes are often observed to go to ground after long, horizontal propagation through the cloud or along its base. Acoustic mapping of two +CG flashes shows thunder sources up to a height of about 15 km throughout he vertical extent of the storm. The radar techniques employed to locate lightning have also been used in aircraft hazards programs, first in Oklahoma and more recently at Wallops Island. These radar capabilities, as well as other aspects of this overview paper, are discussed in greater detail in other papers at this conference.

NS-028
SANGREN, K. L., and P. S. RAY. A comparison of techniques to estimate vertical velocities and drop size spectra. Preprints, Conference on Cloud Physics, November 15-18, 1982, Chicago. American Meteorological Society, Boston, 306-309 (1982).

Vertically pointing Doppler radars are potentially valuable tools for high resolution measurement of raindrop size distributions and vertical air motions. However, the computational interdependence of the two quantities has limited the accuracy of the Doppler results. In particular, drop size distributions are quite sensitive to errors in the vertical velocity estimate. A new dual-wavelength Doppler technique has been applied in an effort to reduce these errors. Results are compared to those obtained with the widely-used Rogers method and with extensions of the Hauser-Amayerc 3P method.

NS-029
Smythe, G. R., and D. S. ZRNIC'. Correlation analysis of Doppler radar data and retrieval of the horizontal wind. Journal of Climate and Applied Meteorology 22: 297-311 (1983).

A technique for tracking perturbations of radial velocity and reflectivity data obtained with a single-Doppler radar is described. Application of the technique to two different scans of the same spatial region leads to the extraction of a field of wind vectors with both radial and azimuthal components. This is accomplished by displacing, in range and azimuth, small volumes or "boxes" of data from the earlier scan and then correlating them with boxes of equal dimensions from the later scan. The displacements at which the correlation coefficients maximize are assumed to be due to the advection of perturbations existing at scales up to the "box" dimensions. Correlation coefficients from radial velocities are shown, for the clear air cases analyzed, to be higher than those from reflectivity (dBZ). Winds retrieved by correlating velocities and reflectivities independently are compared with each other and with winds synthesized from data of two Doppler radars. Winds from radial velocity correlations agree better with the dual-Doppler winds than do winds from reflectivity correlations. Waves of -5 km are revealed in the planetary boundary layer. Also, correlation coefficients are least-squares fitted to the curve $1-x^{\alpha}$, where x is either the spatial or temporal coordinate, as proposed by Chandrasekhar (1955).

NS-030
TAYLOR, W. L., W. D. RUST, D. R. MACGORMAN, and E. A. BRANDES. Lightning activity observed in upper and lower portions of storms and its relationship to storm structure from VHF mapping and Doppler radar. Preprints, International Aerospace and Ground Conference on Lightning and Static Electricity, Ft. Worth, Texas, 6/21-23/83 (1983).

Two recording sites separated by about 40 km are used to observe simultaneously the radio frequency signals produced by lightning. Using time difference-of-arrival techniques, the azimuth and elevation angles to lightning sources producing signals in the VHF (30-80 MHz) band are obtained as a function of time. Three-dimensional locations of lightning are then mapped as a function of space and time in later computer analysis. Detailed analyses of mapped lightning flashes and 10-cm Doppler radar data have been completed for four storms on June 19, 1980. In these storms, VHF sources from lightning processes for cloud-to-ground (CG) and for large intracloud (IC) flashes are confined to an altitude below about 10 km. The average height of VHF sources is 4-5 km for CG flashes and 5-06 km for IC flashes which places most lightning in the -15 C to -20 C temperature region. The median horizontal extent of CG and IC lightning activity is 10 km and 17 km, respectively, with occasional IC flashes extending to greater than 100 km. Both CG and IC lightning activity is centered on the main high reflectivity region of a storm and downwind from strong updraft regions. There is another class of IC flashes that produces a scattering of VHF sources within the main electrically active region of a storm and also in a large canopy over the main discharge region to altitudes of 16 km or more. There is approximately the same number of VHF sources above 10 km from these relatively minor high altitude IC flashes as from the CG and low altitude IC flashes. The high altitude IC flashes produced almost a continuum of activity centered at a height of 12-13 km. This lightning activity also tends to be centered on the main reflectivity column in the cloud and to be in the upper parts of the outflow region in the top of the storm. There seems to be no temporal association between the small flashes occurring almost continuously above 10 km and the large flashes sporadically occurring in the lower portions of storms. This means we are probably dealing with two classes of lightning, which may indicate different charging mechanisms and different discharging processes and which may pose different levels of hazard to aircraft.

NS-031
   Zawadzki, I., A. Woldvogel, R. Rinehart, J. Keeler, P. RAY, and R. Humphries. Ground detection radar-meteorology (GDR). Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada, 186-191 (1983).

   No abstract.

NS-032
   ZIEGLER, C. L., and P. S. RAY. Retrieval of microphysical and variables in observed convective storms. Preprints, Conference on Cloud Physics, November 15-18, 1982, Chicago. American Meteorological Society, Boston, 427-430 (1982).

   A warm-cold cloud microphysical model based on time-dependent heat and water continuity equations, has been developed for the purpose of studying observed convective cloud microphysical structure. The model is linearized by observed wind fields and integrated to steady state using standard numerical techniques. Given cloud wind fields and an environmental sounding, the model outputs temperature and water vapor, cloud water, rain water, hail, and ice mixing ratios at fixed gridpoints throughout the model domain. Model applicability depends on the quasi-steadiness of observed deep convective storm wind and water fields. Provided the observed storm contains sufficient concentrations of hydrometeors and accretion processes are dominant, the water fields are likely to rapidly adjust to changing wind fields. This mechanism relaxes the restriction of quasi-steadiness of the input wind field. A version of the model using a bulk warm cloud microphysical parameterization has been tested on a proxy data set generated by the 3-dimensional deep moist convective cloud model of Klemp and Wilhelmson (1978). Dynamic temperature retrieval experiments using this data set as input have been conducted by Hane et al. (1981). Results of model runs indicate that the proxy temperature and water fields are in a quasi-steady state. The model satisfactorily reproduces those fields, using an arbitrary initial state and the proxy wind fields adjusted for storm motion. The full warm-cold cloud microphysical model is currently being tested on Doppler-derived wind fields. The test results using the proxy data suggest that the model is capable of providing data on microphysical structure in convective storms on an unprecedented scale.

NS-033
   ZIEGLER, C. L., P. S. RAY, and N. C. Knight. Hail growth in an Oklahoma multicell storm. Journal of Atmospheric Science 40 (7): 1768-1791 (1983).

   Hail growth in an Oklahoma multicellular storm is studied using a numerical model of hailstone growth and decay, and dual Doppler derived wind fields. Hail was collected at the time of the Doppler radar data collection which provided input for computation of the modeled trajectories. A unique feature of this investigation is the subsequent comparison of model hail trajectories with deuterium derived trajectories obtained from the hail samples. Formation of large hail is found to be almost entirely due to injection of embryos into the major storm updraft from the upwind side, with subsequent growth occurring during repeated vertical excursions through the prime growth layer between 7 and 8 km. Primary embryo

source regions are a feeder cell and the precipitation debris region between the feeder and main cells. Qualitative comparisons between observed and modeled hailstones falling near the collection site reveal storng similarities, particularly with respect to ambient temperature during ice formation and layer structure. Horizontal advection of hail across the updraft during growth is typical, so that particle recirculation in a single updraft is unimportant for hail growth. Observed hail size distributions are related to the distributions of modeled hailstones at the ground. Either a modal or "leveling-off" tendency is evident in each of the hail samples, whose shapes agree qualitatively with the distribution of numerically simulated large hail falling in the vicinity of the storm core at the surface. The gamma function is found to generally provide a better fit to the sample distributions than the Marshall-Palmer function.

NS-034

ZRNIC', D. S. Considerations for observations of storms. Proceedings of the NEXRAD/CIMMS Symposium on Doppler Radar, September 22-24, 1982, Norman, Oklahoma, 124-143 (1982).

The NEXRAD design must incorporate techniques for range and velocity dealiasing and suppression of stationary ground targets. It is unlikely that an economically effective unambiguous range for velocity estimates would extend to the required 250 km. The scan rate and signal processing must allow observations with sufficient resolution and speed so that hazardous weather features with lifetimes exceeding 5 minutes can be recognized.

NS-035

ZRNIC', D. S., R. J. DOVIAK, J. T. LEE, and R. S. Ge. Characteristics of gust front and downdrafts from single Doppler radar data. Preprints, 21st Conference on Radar Meteorology, September 19-23, 1983, Edmonton, Alberta, Canada, 650-656 (1983).

Low level wind shear associated with gust fronts has been related to several aircraft accidents. The Federal Aviation Administration has supported the National Severe Storms Laboratory in comprehensive study of gust fronts using Doppler radar data and measurements from surface stations and a tall tower. We present radar derived parameters such as reflectivity, height, maximum shear, peak velocity, distance of the front from the producing storm and the nearest 30 dBZ contour for several gust fronts within 60 km of the radar during 1980 to 1982. For all orientations of the front, even along the radial direction, the frontal discontinuity was evident in both mean velocity and spectrum width fields. Thus, while detection is practical with a single Doppler radar, accurate estimation of shear magnitudes is more difficult when the frontal discontinuity is aligned along the radial.

NS-036

ZRNIC', D. S., S. Hamidi, and A. ZAHRAI. Considerations for the design of ground clutter cancelers for weather radar. FAA Final Report, DOT/FAA/RD-82/68, 27pp (1982).

Effects of the ground clutter ring in the second trip area for velocity estimation are investigated. Besides unfavorable effects on weather signal due to range square advantage, the clutter poses a new problem when interlaced samples for assigning correct ranges to velocity estimates are use. The problem arises because signals that generate reflectivity estimates for power comparisons cannot be filtered in the same manner as signals from which velocity estimates are generated. Therefore, comparison of powers in the reflectivity and velocity channels is required. Performance of a third order recursive elliptic filter is analyzed. The filter operates best in steady state, but it can also be made to operate in transient by properly initializing its memory elements. Performance on 8 simulated time samples shows that about 10 dB of clutter to signal margin is lost for power and 20 dB for mean velocity estimation; with such a small number of samples, the width estimate is useless. In order for spectrum width biases to be less than $1 \text{ m} \cdot \text{s}^{-1}$, a longer train of pulses must be employed on an initialized filter and several of the leading pulses must be used exclusively to further reduce the transients. These problems do not arise when canceling is done on an uninterrupted pulse train. Examination of hardware for implementing the recursive filter demonstrates that two identical cancelers, one for the inphase, the other for the quadrature signal are needed. The device consists of an arithmetic and logic unit assisted by four multipliers; through put rate is faster than $1 \mu s$.

NS-037

ZRNIC', D. S., L. D. HENNINGTON, and J. SKELTON. Automatic recognition of mesocyclones from single Doppler radar data. Final Report, AFGL-TR-82-0291, dtd 7 October 1982.

An algorithm to automatically detect mesocyclonic shear from radial velocity data of a Doppler radar is developed. The algorithm searches for azimuthally increasing velocities. Runs of increasing velocities

are stored and the resulting shears are compared to mesocyclonic shear thresholds. Also, products of velocity differences are multiplied with the corresponding are lengths and then compared to "momentum" thresholds. Those runs that pass a set of such thresholds and are spatially close are identified as belonging to a region of mesocyclonic shears or a shear line. The algorithm requires simultaneous storage and operation on two consecutive radials of data, and thus is suitable for real time implementation. Flow charts and performance on two data sets are presented.

PM-001
Allen, J. S., R. C. Beardsley, J. O. Blanton, W. C. Boicourt, B. Butman, L. K. Coachman, A. Huyer, T. H. Kinder, T. C. Royer, J. D. SCHUMACHER, R. L. Smith, W. Sturges, and C. D. Winant. Physical oceanography of continental shelves. Reviews of Geophysics and Space Physics 21:1149-1181 (1983).

No abstract.

PM-002
BAKER, E. T., and H. B. MILBURN. An instrument system for the investigation of particle fluxes. Continental Shelf Research 1:425-435 (1983).

We present the rationale, design, and use of an instrument system to measure the variability of vertical and horizontal particle fluxes. The system features a new sequentially sampling sediment trap which collects and seals 10 separate samples during a single deployment. Horizontal particle fluxes are simultaneously monitored with a beam transmissometer interfaced to a standard Aanderaa current meter. Results from a 10-week deployment of instruments at several depths in a deep fjord estuary indicate that the trapping rate increases from ~0.5 g m^{-2}day^{-1} at 20 m to ~150 g m^{-2}day^{-1} at 200 m (5 m above bottom) because of frequent erosion in the deep waters. Periodic flushing of the deep water by intrusions of marine water over the seaward sill markedly enhances erosion and causes an up-estuary particle transport comparable to the vertical particle flux originating at the surface.

PM-003
BAKER, E. T., and S. L. WALKER. Suspended particulate matter in Commencement Bay. NOAA-TM-ERL-OMPA-26 (PB82-246943), 47 pp. (1982).

The distribution and transport of suspended particulate matter (SPM) in Commencement Bay, an embayment of Puget Sound, was surveyed during September 9-11, 1980; November 12-14, 1980; and March 23-27, 1981. During each survey the SPM distribution consisted of: (1) a thin (<5 m) surface layer of variable SPM concentration; (2) a thick mid-depth low turbidity zone containing one or more high-turbidity layers extending seaward from the head of the Bay; and (3) a benthic turbidity layer of high variable concentration and thickness. The total mass of SPM in the Bay averaged 19.7 × 10^{8}g and varied by <10 percent between surveys. Scatter plots of salinity versus the SPM concentration in the surface water had the highest correlation during high runoff periods (r = -0.86 in March and November, -0.59 in September). Correlations of these parameters in the bottom waters were uniformly poor. Horizontal transport of SPM was measured in the near-bottom waters at two stations with current meter/transmissometer combinations deployed from September 10 to November 13, 1980. Bottom-water flow was consistently clockwise with mean speeds ~5.4 cm/sec and mean attenuation values ~2.4/m. SPM transport averaged ~12.7 μg/cm^2/sec at each station. Vertical particle flux, measured at the same stations from March 25 to May 4, 1981, averaged ~5.5 g/m^2/day at 25 m and >80 g/m^2/day in the bottom waters. Transport of SPM in the surface layer was controlled by the Puyallup River plume and a weak counterclockwise circulation. Mid-depth turbidity layers extending seaward from the head of the Bay were common and appeared to be generated by bottom erosion near the river mouth. Transport in the bottom water was governed by daily erosion/deposition cycles which added suspended particles to a strong and steady clockwise circulation.

PM-004
BATES, T. S., S. E. HAMILTON, and J. D. CLINE. Collection of suspended particulate matter for hydrocarbon analyses: continuous flow centrifugation vs. filtration. Estuarine, Coastal and Shelf Science 16:107-112 (1983).

High-speed, continuous-flow centrifugation and glass-fiber filtration were used to collect suspended matter from river water and waste water effluent for hydrocarbon analyses. Both methods collected equivalent weights of total suspended matter and similar particle size distributions and were >90% efficient for particles >4.0 μm. Glass-fiber filters retained more lipid-extractable organic matter and saturated hydrocarbons than did continuous-flow centrifugation. Adsorption of dissolved or colloidal organic compounds onto glass-fiber filters resulted in an overestimate of the organics associated with particulate matter.

PM-005

BERNARD, E. N. A tsunami research plan for the United States. <u>Earthquake Engineering Research Institute</u> 17:13-26 (1983).

In response to the identification of areas of deficiency in tsunami research, a group of scientists and government representatives developed a coherent research plan to address these problems. The plan is designed to foster a course of action that will focus research on forecasting tsunami dangers and evaluating coastal hazards. A brief review of the status of tsunami research is presented and needs for priority research are identified. The three highest need areas are 1) tsunami observational program, 2) modeling and design related to terminal effects, and 3) tsunamigenic earthquake identification. Two moderate need areas include the creation of a tsunami data set and the development of emergency preparedness programs.

PM-006

BERNARD, E. N., J. F. Lander, and G. T. Hebenstreit. Feasibility study of mitigating tsunami hazards in the Pacific. NOAA-TM-ERL-PMEL-37 (PB83-156885), 41 pp. (1982).

This study shows that many aspects of existing U.S. technology have potential applications to the problem of providing early tsunami warning information in developing nations of the Pacific which do not have their own regional warning network. A simple conceptual model is developed which shows how these technologies could be integrated into an early warning "system." The basic elements are described for a demonstration program which would confirm the practicality of such a technologically feasible system. Such a demonstration--to which the acronym THRUST (<u>T</u>sunami <u>H</u>azard <u>R</u>eduction <u>U</u>tilizing <u>S</u>ystem <u>T</u>echnology) is applied--would be a significant step toward achieving the goal of hazard mitigation in the developing areas of the Pacific community. It is recommended that an active program of tsunami hazard reduction in developing nations be established within the Office of U.S. Foreign Disaster Assistance of the Agency for International Development.

PM-007

Brink, K. H., D. HALPERN, A. Huyer, and R. L. Smith. The physical environment of the Peruvian upwelling system. <u>Progress in Oceanography</u> 12:285-305 (1983).

Knowledge of the characteristics of the physical environment of the Peru coastal upwelling zone has increased greatly during the past decade. Observations made during 1976 and 1977, many made as part of the Coastal Upwelling Ecosystem Analysis JOINT-II expedition, provide the basis for an interpretative description of the physical processes and phenomena occurring in Peru coastal waters. Four important phenomena are discussed: wind-driven upwelling, the poleward undercurrent, surface mixed layer deepening, and low-frequency coastal-trapped waves. The coastal winds were invariably favorable for coastal upwelling, even during the 1976 El Niño. The agreement between the offshore transport in the relatively shallow (30 m) surface layer and the Ekman transport, deduced from the local wind, was good for both the mean and variable state. The agreement with the deeper onshore transport was less good, consistent with the marked three-dimensionality and spatial variability of the upwelling. The poleward undercurrent was apparently continuous from 5°S to at least 15°S, flowing just below the surface layer over the continental shelf and slope, and supplying the upwelling water. The variability in the alongshore velocity field was dominated by baroclinic free coastal-trapped waves with periods of 5-20 days. Although there is appreciable temporal and spatial variability in the Peru coastal upwelling system, the upwelling, the undercurrent, and the low-frequency coastal-trapped waves were ubiquitous.

PM-008

BYRNE, H. M. STREX TOVS/Radiosonde comparison. Part I: TOVS/AVHRR and radiosonde inventory. NOAA-DR-ERL-PMEL-8 (NTIS number not yet available), 135 pp. plus microfiche, 401 pp. (1982).

No abstract.

PM-009

BYRNE, H. M. The variation of the drag coefficient in the marine surface layer due to temporal and spatial variations of the surface wind and sea state. NOAA-TM-ERL-PMEL-49 (NTIS number not yet available), 116 pp. (1983).

The neutral atmospheric drag coefficient, C_{dn}, and ocean surface wave spectra were measured on both sides of a strong atmospheric front. The front was part of a mature extratropical cyclone moving across the Gulf of Alaska on 15 November 1980. Results showed a large variation in C_{dn} at constant mean wind speed in the cold sector which could not be explained by formulations found in the literature. Previous

work which attempted to relate drag coefficients to surface wind speed paid slight attention to the coincident surface wave field. As a result, no explicit dependence of C_{dn} on the wave field has ever been reported. This investigation, which measured the complete one-dimensional surface wave spectrum, constitutes the first time wave spectral measurements that have been made together with eddy correlation flux measurements in marine surface layer. Coincident wave spectral measurements showed an unexpected increase in energy in the six-second wave band ($.15\rightarrow.17$ hz), which was correlated with the variation C_{dn}. The spatial distribution of wave spectral energy in the duration-limited sea behind the 15 November front was found to differ markedly from the spatial distribution of wave spectral energy in the fetch limited case. The wave spectra in the warm sector followed Phillips' model well. The wave spectra in the cold sector did not. Using only the wave spectral information, a representation of z_o was derived which reduced to Charnock's relation in situations of dynamic equilibrium between the wind field and the surface waves. In situations of disequilibrium between the wave field and the surface wind, the derived relation showed a dependence of z_o on the six-second wave field. We found that C_{dn} calculated from measurements made during the 15 November 1980 frontal penetration, and the 7 November post-frontal flight followed the derived z_o relationship. This relationship of z_o to the surface wave spectra helps explain the high values of C_{dn} behind moving fronts which have been reported in the literature.

PM-010
BYRNE, H. M., and P. E. PULLEN. SEASAT-derived ocean surface topography: comparison with coincident Kuroshio hydrographic data. Journal of Geophysical Research 88:2621-2625 (1983).

During the SEASAT repeat-orbit period, a CTD and deep (1800 m) XBT hydrographic experiment was conducted across the Kuroshio to obtain cotemporaneous surface topography measurements for comparison with the altimeter-derived surface height measurements. The results showed that the altimeter could detect and measure the change in sea surface topography caused by movement of the Kuroshio and the cold rings that were found in the hydrographic data. After compensation for the small differences in the time of the measurements, the altimeter measured changes in the surface topography that matched those measured by the hydrographic sections with an average difference of 9.6 cm for the 41 comparison points.

PM-011
CANNON, G. A. An overview of circulation in the Puget Sound estuarine system. NOAA-TM-ERL-PMEL-48, (NTIS number not yet available), 30 pp. (1983).

The estuarine system that comprises Puget Sound and the Strait of Juan de Fuca, the southernmost, glacially carved waterways in western North America, is a complex composite of several connecting basins. Observations of circulation were made at a central location in the Main Basin of Puget Sound under various conditions during the past ten years. Intrusions of deep water below sill depth occurred at about fortnightly intervals, but not every fortnight. Flux calculations and water properties suggest a propagation of the intruded water along the Sound between Seattle and Tacoma in a little more than one week. A recent conceptual model, however, implies mixing of seaward-flowing surface water with the intruding deeper water. Present rough estimates are that below about 50 m only about half of the bottom water moving south past Seattle is new water from outside. Observations of mean daily current profiles in the Sound show significant deepening of the level of no-net-horizontal motion from about 50 m to as much as 100 m in approximately 200 m total depth. Winds along the Sound apparently can alter a fairly delicate balance of forces due to relatively small horizontal pressure gradients. In the Strait of Juan de Fuca, the waterway connecting the Sound with the Pacific Ocean, winter storms with predominantly southerly winds along the coast are capable of significantly reversing the normal estuarine flow and causing large intrusions of coastal water lasting several days. Outflow often occurs only in the deeper water with surface water being retained within the Strait.

PM-012
CLINE, J. D., H. B. MILBURN, and D. P. WISEGARVER. A simple rosette-mounted syringe sampler for the collection of dissolved gases. Deep-Sea Research 29:1245-1250 (1982).

This report describes the design and operation of a simple syringe sampler for the collection of dissolved gases. The samples may be used to collect dissolved trace metal samples where modest volumes are required ($V \leqq 500$ ml). The sampler was designed to attach to a standard rosette, but could be modified to attach directly to a wire. Preliminary testing was accomplished by analyzing North Pacific waters for dissolved trichlorofluoromethane (Freon®-11) down to concentrations of 2×10^{-14} M. The data indicate that samples can be stored for periods up to 6 h with no significant contamination.

PM-013
CURL, H. J., JR., ed. Estuarine and coastal pollutant transport and transformation. The role of particulates, FY80-82 Summary Report and FY82 Annual Report. A project under the NOAA/OMPA Section 202 Research Program. PMEL, 228 pp. (1982).

No abstract.

PM-014
FEELY, R. A., and C.-T. A. Chen. The effect of excess CO_2 on the calculated calcite and aragonite saturation horizons in the northeast Pacific. Geophysical Research Letters 9:1294-1297 (1982).

Using the ΔTCO_2° results of Chen (1982a) obtained during a cruise in the northeast Pacific Ocean (June-July 1981), we have calculated preindustrial and 1981 calcite and aragonite saturation horizons for a transect along 150°W between Alaska and Hawaii. Uptake of excess CO_2 by the oceans over the past 130 years has resulted in a significant change in the carbonate chemistry of the northeast Pacific Ocean. The results indicate an apparent reduction in the thickness of the supersaturated lenses and an upward translation of the 100% saturation level by as much as 150 meters for calcite and 70 meters for aragonite in the cold-water region north of the Subarctic Front.

PM-015
FEELY, R. A., G. J. MASSOTH, and M. F. LAMB. The effect of sewage effluents on the flocculation of major and trace elements in a stratified estuary. In Trace Metals in Sea Water, C. S. Wong, E. A. Boyle, K. W. Bruland, J. D. Burton, and E. D. Goldberg (eds.), Plenum Publishing Corporation, New York, Chapter 4, 227-244 (1983).

In order to study the effects of sewage effluents on the flocculation of trace elements in a stratified estuary, water samples were collected from the Duwamish River Estuary at stations located above and below the Renton Sewage Disposal Site. The water samples were filtered through 0.2-μm pore size Nuclepore filters, the filtrate mixed with various amounts of filtered sea water from Elliott Bay, and the products refiltered onto 0.2-μm filters and analyzed for major and minor elements by x-ray secondary emission spectrometry. The results show that the downstream samples produced two to three times more flocculated material and three to five times more P, Ca, Fe, Ni, Cu and Zn than the upstream samples. In contrast, little differences were found for Al and Ti. Similar experiments utilizing the effluent from the Renton Sewage Treatment Plant also showed the same trends, suggesting that the sewage effluent enhanced the flocculation of these elements in the estuary. Major element analysis of the flocculated material indicates that it is mainly composed of organic material.

PM-016
Gammon, R. H., J. CLINE, and D. WISEGARVER. Chlorofluoromethanes in the Northeast Pacific Ocean: measured vertical distributions and application as transient tracers of upper ocean mixing. Journal of Geophysical Research 87:9441-9454 (1982).

The vertical distributions of the man-made chlorofluoromethanes CCl_3F (F-11) and CCl_2F_2 (F-12) have been measured at two locations in the eastern North Pacific Ocean to depths greater than 500 m. At both sites (46°N, 125°W off the Washington-Oregon coast and 50°N, 140°W in the Gulf of Alaska) the halomethane concentrations were found to fall off exponentially with increasing depth below the mixed layer. For F-11 at 50°N, the surface concentration (3.2×10^{-12} mol/l) was found to be in saturation equilibrium with the measured atmospheric concentration (190 pptv). The measured chlorofluoromethane profiles have been interpreted in terms of a one-dimensional model for the vertical diffusion/advection of an exponentially driven, conservative tracer into a bottomless ocean. In the appropriate limit of 'transient steady state' the projected profiles are simple exponentials described by an advective-diffusive scale depth H, which is a function of the vertical eddy diffusivity K_2, the upwelling velocity w, and the characteristic time τ for the exponential growth of the tracer concentration at the boundary. At the two ocean locations studied the freon thermocline depth scales were in the range $H \cong 120-140$ m, with F-12 generally 10-20% deeper than F-11. At 50°N the F-11 and F-12 vertical profiles gave consistent values of vertical diffusivity ($K_2 \sim 1.2-1.3$ cm^2s^{-1}) and upwelling velocity ($w \cong 12-14$ m yr^{-1}). The model also allows a simple scaling from one exponentially driven, transient tracer (freon) to another (fossil fuel CO_2), leading to a predicted mean depth of penetration of fossil fuel CO_2 of approximately 300 m in the eastern North Pacific.

PM-017
HALPERN, D. Annual and interannual current and temperature fluctuations in the eastern Pacific upper ocean. Tropical Ocean-Atmosphere Newsletter 16:17-19 (1983).

No abstract.

PM-018
HALPERN, D., E. Harrison, B. Hinton, R. Long, M. Mathur, J. O'Brien, S. Payne, S. Pazan, and J. Sadler. Intercomparison of tropical Pacific mean November 1979 surface wind fields. Technical Report, Department of Meteorology and Physical Oceanography, Massachusetts Institute of Technology, Cambridge, MA, 40 pp. (1982).

No abstract.

PM-019
HALPERN, D., S. P. HAYES, A. Leetmaa, D. V. Hansen, and S. G. H. PHILANDER. Oceanographic observations of the 1982 warming of the Tropical Eastern Pacific. Science 221:1173-1175 (1983).

Oceanographic observations of the unexpected development of the 1982 equatorial Pacific warm event were made fortuitously because the upper ocean circulation and thermal fields were already being studied in the anomalous region. A preliminary description of the anomalous changes is given. In August the near-surface flow at 0°, 110°W reversed direction to eastward. By October sea level rose by 22 cm at the Galápagos Islands, the sea surface temperature in the equatorial zone increased by 5°C, and the thermocline was displaced downward by 50-75 m.

PM-020
HALPERN, D., and R. A. Knox. Coherence between low-level cloud motion vectors and surface wind measurements near 0°, 152°W from April 1979 to February 1980. Atmosphere-Ocean 21:82-93 (1983).

Low-level cloud motion vectors determined by the National Oceanic and Atmospheric Administration (NOAA) and the University of Wisconsin in a 5-degree square centered at 0°, 152°30'W were intercompared with moored buoy wind measurements made at 0°, 152°W during April 1979 - February 1980. At the site of the intercomparison test the prevailing wind direction was easterly; monthly mean values of the meridional wind speed were less than 20% of the zonal component. The surface winds measured during the observational period were similar to the climatological-mean wind conditions. Although the satellite wind speeds were larger than buoy wind speeds, as a priori expected, because of the vertical separation between the measurements, the comparison indicated that in the case of the zonal component there was a maximum usable frequency (muf) below which cloud drifts and surface wind vectors were 95% significantly correlated and the correlation was greater than the 50% noise level. The muf were 0.17 and 0.3 cpd for the NOAA and Wisconsin cloud motion vectors, respectively. At frequencies below the muf, an algorithm describing the frequency-dependent differences of the rms zonal wind speed amplitudes was developed. Coherences involving the meridional wind speeds were too low for the estimation of a muf.

PM-021
HAYES, S. P. A comparison of geostrophic and measured velocities in the Equatorial Undercurrent. Journal of Marine Research 40:219-229 (1982).

Profiles of zonal velocity in the upper 500 m at the equator are computed from the differentiated form of the geostrophic relation $\left(u = -\frac{1}{\beta\rho}\frac{\partial^2 p}{\partial y^2}\right)$ using four CTD sections at 110°W and one section at 125°W. The meridional curvature of the pressure field between 1°N and 1°S was estimated by fitting a second order polynomial to the dynamic height (relative to 500 db) at each pressure surface. Computed profiles all indicated an equatorial undercurrent at an approximate depth of 70 db and amplitude of 150 cm s^{-1} relative to the minimum speed near 200 db. The rms deviation between computed and directly measured velocity differences from the undercurrent core to 250 m was 34 cm s^{-1} which is about 20% of the mean difference. These results provide strong evidence for the importance of geostrophy within 1° of the equator.

PM-022
HAYES, S. P. The 1982 event in the Galápagos sea level array. Tropical Ocean-Atmosphere Newsletter 16:17-18 (1983).

No abstract.

PM-023
HAYES, S. P., and L. J. MANGUM. Velocity/CTD measurements at 110°W and 95°W, October-November 1982. <u>Tropical Ocean-Atmosphere Newsletter</u> 16:14 (1983).

No abstract.

PM-024
HAYES, S. P., J. M. TOOLE, and L. J. MANGUM. Water-mass and transport variability at 110°W in the equatorial Pacific. <u>Journal of Physical Oceanography</u> 13:153-167 (1983).

An analysis of nine hydrographic sections collected in 1979-81 along 110°W in the equatorial Pacific Ocean is presented. Sections typically sampled the upper 500 m of the water column from 10°N to 3°S. Analysis concentrated on the repeated sections north of the equator. Examination of the variability of eastward transport indicates that the North equatorial Countercurrent (NECC) and the Northern Subsurface Countercurrent (NSCC) cannot be distinguished solely on the basis of water-mass structure. However, using a potential density surface ($\sigma_\theta = 25.0$) as a current boundary we find that on average the NSCC transports 13.7×10^6 m^3 s^{-1} compared to only 8.3×10^6 m^3 s^{-1} for the NECC. The NSCC flow is sufficiently stable so that meridional surface dynamic-height gradient remains a good index of zonal transport fluctuations. Variations in surface dynamic height observed in our data and in the EASTROPAC data indicate a seasonal cycle to the surface topography with large values for the equatorial and countercurrent depressions in boreal autumn and small values in spring. Broad meridional correlation scales for surface dynamic height were found; equatorial fluctuations were significantly positively correlated with variability at latitudes out to 5°N and significantly negatively correlated with variability at 9-10°N. The meridional and vertical structures of vertical displacement were reduced to two empirical orthogonal function (EOF) modes which contained 78% of the variance. These modes did not suggest simple dynamical interpretation in terms of first-vertical-mode linear waves.

PM-025
HOLBROOK, J. R., and D. HALPERN. Winter-time near-surface currents in the Strait of Juan de Fuca. <u>Atmosphere-Ocean</u> 20:327-339 (1982).

During November 1976 to February 1977 near-surface wind, current and temperature measurements were made at three sites along the Strait of Juan de Fuca. Strong tidal currents and major intrusions of warmer, fresher offshore coastal water were superimposed upon the estuarine circulation of near-surface seaward flow. The r.m.s. amplitudes of the diurnal and semidiurnal tidal currents were ~30 cm s^{-1} and 30-47 cm s^{-1}, respectively. The vector-mean flow at 4 m-depth was seaward and decreased in speed from 28 cm s^{-1} at 74 km from the entrance to 9 cm s^{-1} at 11 km from the entrance. On five occasions intrusions of 1-3°C warmer northeast Pacific coastal water occurred for durations of 1-10 days. The 25 cm s^{-1} up-strait speed of the intrusive lens agreed to within 20% of the gravity current speed computed from Benjamin's (1968) hydraulic model. The near-surface currents associated with the intrusions and the southerly coastal winds were significantly correlated, indicating that the intrusions were initiated when shoreward Ekman currents advected Pacific coastal water into the Strait. The reversals were not significantly coherent with the along-strait sea surface slope measured along the north side of the Strait nor were they strongly related to local wind forcing.

PM-026
HOLBROOK, J. R., G. A. CANNON, and D. G. KACHEL. Two-year observations of coastal-fjord interactions in the Strait of Juan de Fuca. In <u>Coastal Oceanography</u>, J. A. Kong (ed.), NATO Advanced Research Institute, Plenum Press, New York, 411-426 (1983).

During the two-year period between March 1979 and March 1981, continuous measurements of currents, water temperature and salinity, winds, sea level and water pressure were made in the Strait of Juan de Fuca, a fjord-like estuary between Washington State, U.S.A. and Vancouver Island, Canada. These observations along with satellite imagery and CTD surveys show that surface intrusions of less dense coastal waters into the Strait are a major, recurring feature of its general circulation. These intrusions, which are accompanied by reversals in the normally vigorous, two-layer estuarine flow, are correlated with southwesterly coastal winds (conducive to coastal downwelling) and rising sea level at the entrance. These data suggest that a wind-induced, shoreward Ekman flux along the coast pushes less-dense coastal water into the Strait where it feeds a complex, 3-dimensional density driven flow which has been observed to travel as far as 135 km up-strait. The relationship between these baroclinic events and the along-strait and across-strait sea surface slopes and pressure gradients will be discussed.

PM-027

Kinder, T. H., G. L. Hunt, Jr., D. Schneider, and J. D. SCHUMACHER. Correlations between seabirds and oceanic fronts around the Pribilof Islands, Alaska. Estuarine, Coastal and Shelf Science 16:309-319 (1983).

Located on the extensive continental shelf of the Bering Sea, the Pribilof Islands, Alaska are the site of one of the largest breeding colonies of seabirds in the northern hemisphere. During summer these islands are surrounded by a front that separates vertically homogeneous waters from well stratified waters farther seaward. We studied the front with hydrographic data and the bird distributions with concurrent counts during summer 1977 and spring, summer and fall 1978. Murres (*Uria lomvia* and *U. aalge*) sitting on the water aggregated near the front during summer 1977 and probably during summer 1978. Other species, such as northern fulmars (*Fulmarus glacialis*) and auklets (*Aethia pusilla* and *A. cristatella*) were unaffected by the front. We hypothesize that the aggregation of the murres was related to an enhanced availability of their food near the front.

PM-028

LAGERLOEF, G. Topographically controlled flow around a deep trough transecting the shelf off Kodiak Island, Alaska. Journal of Physical Oceanography 13:139-146 (1983).

Current measurements from the axis of a deep trough normal to the coast and from the adjacent shelf show that the mean flow is barotropic and follows depth contours, conserving potential vorticity, to form a cyclonic vortex or meander over the trough. The data are interpreted as an example of an inertial Taylor-Proudman column on the continental shelf. The scale of the topographic variations dominates the potential vorticity balance and a simple steady-state numerical model is in good agreement with the data when the vorticity balance approaches the limit $U \cdot \nabla H = 0$. Streamlines following isobaths converge over steeper topography and current speeds are nearly proportional to the local topographic gradient. Estimates from the data support this behavior and indicate that the ~20 cm s^{-1} mean current around the trough is driven by a typical cross-shelf-averaged velocity scale of ~5 cm s^{-1}.

PM-029

LAVELLE, J. W., and H. O. MOFJELD. Effects of time-varying viscosity on oscillatory turbulent channel flow. Journal of Geophysical Research 88(C12):7607-7616 (1983).

A semi-analytic model of a time-dependent bottom boundary layer has been constructed in which flow and time-variable eddy viscosity are interdependent. Evaluated in the case of oscillatory forcing at tidal frequencies, the model shows that neglecting time-variations in viscosity results in underestimates of maximum bottom stress and distortion of the flow profile near times of flow reversal. Acceleration and variable viscosity also add terms proportional to $z \ln(z/z_o)$ and z to the conventional steady-state $\ln(z/z_o)$ profile near the bottom. Inferences based on the logarithmic profile for measurements made in time-dependent boundary layers may consequently yield inaccurate estimates of roughness length and friction velocity. Stress is seen to lag flow at points away from the bottom, as has been observed in measurements, though bottom stress always leads flow aloft. Bottom stress is found to depend linearly on the free-stream velocity in the limit of time-varying viscosity. In the limit of strongly time-varying viscosity, bottom stress is more nearly quadratic. The friction coefficients are reasonably time-independent only when the phase lead, θ, between bottom stress, τ_β, and free-stream velocity, U, is incorporated into the bottom friction expression. A generalized bottom drag law for oscillatory flow encompassing all these features takes the form $\tau_\beta = g_\beta |U(t/T+\theta)|^\beta U(t/T+\theta)$, where β has a value between 0 and 1, and θ is typically a few tens of degrees. In the examples evaluated, when $\beta = 0$, g_β (conventionally called r) ranges from 2-15 × 10^{-2} cm/s, and when $\beta = 1$, g_β (conventionally called C_D) ranges from 1-5 × 10^{-3}, the variation in both cases depending on surface Rossby number.

PM-030

MACKLIN, S. A. Wind drag coefficient over first-year sea ice in the Bering Sea. Journal of Geophysical Research 88:2845-2852 (1983).

Profiles of relative wind speed and temperature were collected from four levels over rough sea ice in the marginal ice zone of the Bering Sea and used to compute surface wind drag coefficients. Based upon 138 profiles for near-constant ice conditions, northeast winds of 3-15 m s^{-1}, and near-neutral stability, the mean, near-neutral, 10-m drag coefficient was 0.00309 ± 0.00049. This is among the largest drag coefficients measured for neutral atmospheric conditions over sea ice. Sixty-five percent of the variance of this estimate is explained by orientation of the ice floe to the wind; an additional 5% of the variance is explained by wind-speed dependence. Provided that diabatic atmospheric stability over

the Bering Sea ice pack is well correlated with low wind speed, the significant ice-advecting wind stress on the ice is determined from the neutral value of the drag coefficient, a function of ice roughness length alone. The ice forecaster thus may use remote measurements or estimates of wind speed and surface roughness to assess the wind component of ice advection.

PM-031

McWilliams, J. C., E. D. Brown, H. L. Bryden, C. C. Ebbesmeyer, B. A. Elliott, R. H. Heinmiller, B. L. Hua, K. D. Leaman, E. J. Lindstrom, J. R. Luyten, S. E. McDowell, W. B. Owens, H. Perkins, J. F. Price, L. Regren, S. C. Risa, H. T. Rossby, T. B. Sanford, C. Y. Shen, B. A. TAFT, and J. C. Van Leer. The local dynamics of eddies in the western North Atlantic. In: Eddies in Marine Science, A. R. Robinson (ed.), Springer-Verlag, Berlin Heidelberg, 92-113 (1983).

No abstract.

PM-032

MANGUM, L. J., and S. P. HAYES. CTD/O_2 measurements during 1980 and 1981 as part of the Equatorial Pacific Ocean Climate Study (EPOCS). NOAA-DR-ERL-PMEL-9 (NTIS number not yet available), 621 pp. (1983).

CTD/O_2 data are presented that were collected on eight cruises in the equatorial Pacific during 1980 and 1981. In addition to measurements east of the Galápagos and along the equator to 180°W, the majority of the data were taken along 110°W in 6 sections that continued the work that was begun in 1979. Station locations, meteorological conditions and profiles of temperature, salinity, sigma-T, and oxygen are shown for each cast. T-S diagrams and section plots along 110°W of oceanographic variables are also included. These measurements are a component of the Equatorial Pacific Ocean Climate Study (EPOCS) program of NOAA.

PM-033

OVERLAND, J. E., R. M. REYNOLDS, and C. H. PEASE. A model of the atmospheric boundary layer over the marginal ice zone. Journal of Geophysical Research 88:2836-2840 (1983).

A one-layer, primitive equation model is presented for the atmospheric boundary layer over the marginal ice zone (MIZ). The model simulates the slow rate of inversion growth and rate of warming of the boundary layer seaward of an ice edge for off-ice winds observed on two cruises in the Bering Sea by the NOAA R/V Surveyor. The horizontal temperature gradient in the boundary layer, caused by the oceanic heat flux seaward of an ice edge, induced an increase in wind speed with a maximum increase of 8% at 50 km seaward of the edge. At 100 km off ice, a momentum balance is established between accelerative terms (boundary layer baroclinity, momentum entrainment, synoptic-scale scale pressure gradient) and decelerative terms (surface drag and the local pressure force resulting from inversion rise). Wind velocity in the boundary layer over the MIZ during off-ice winds is sensitive to changes in surface roughness. When an MIZ is modeled as a smooth interior ($C_D = 2 \times 10^{-3}$) and a 30-km-wide rough marginal ice zone ($C_D = 3.8 \times 10^{-3}$) with an unstable surface layer over the ocean, the model shows a decrease in wind speed of 9% at the windward side of the MIZ and an 18% increase in wind speed from 5 km interior to the ice edge to 40 km seaward of the edge. These results suggest an atmospheric mechanism for rafting at the windward side of the marginal ice zone, divergence of the ice at the edge, and ice-band formation seaward of the edge.

PM-034

OVERLAND, J. E., and B. A. WALTER, JR. Marine weather of the inland waters of western Washington. NOAA-TM-ERL-PMEL-44 (PB83-207811), 62 pp. (1983).

The mid-latitude, west coast marine climate of western Washington is typified in summer by high sea-level pressure as part of the North Pacific weather pattern and in winter by a sequence of storms which originate to the west. Mean and extreme temperatures are moderated by the proximity of the Pacific Ocean and Puget Sound, resulting in a mean temperature of 4°C in January and 17°C in August at Seattle. Local variations in precipitation and wind are influenced by both large-scale weather patterns and the region's topography. Fifty percent of the annual precipitation for most of the inland region falls in the four months from November through February, and less than five percent falls in July and August; the driest region is to the northeast of the Olympic Mountains. Over the inland waters, the winds flow from high to low sea-level pressure in the direction of the local channels. Recent studies by the University of Washington and PMEL on the Puget Sound convergence zone, sea and valley breeze, precipitation patterns and local wind patterns are summarized. The storm which resulted in destruction of the Hood Canal Bridge has shown that the presence of the Olympic Mountains can induce a regional low-pressure system in their lee which can result in strong surface winds over the inland waters.

PM-035
PEASE, C. H., S. A. SALO, and J. E. OVERLAND. Drag measurements for first-year sea ice over a shallow sea. _Journal of Geophysical Research_ 88:2853-2862 (1983).

For a free-drift case a method is developed for simultaneously determining air (C_a) and water (C_w) drag coefficients by solving the vertically integrated stress balance equation for sea ice. The method allows the algebraic determination of C_a and C_w from measurements of relative wind and relative current at single reference levels, from estimates of the densities of all three fluids and ice thickness, and from estimates of the accelerations caused by the nonsurface stress terms derived from position measurements. The method treats the ice as a natural drag plate and therefore includes contributions from both skin and form drag. One shortcoming of the technique is that if the relative wind and current are colinear, then only the ratio of C_a and C_w can be determined. Another is that the accelerations caused by other forces need to be independently determined. An experiment was conducted on a single floe in the eastern Bering Sea over the continental shelf during March 1981. The site was about 80 km from the ice edge and was occupied for approximately 3 days following the passage of a storm which had broken the pack into 10-20 m diameter floes. Both profile and slab inversion estimates of drag were made from the current meter and anemometer measurements at the site: C_a at 3 m was 4.55×10^{-3} by the profile method, compared to 3.63-4.39×10^{-3} for slab, depending on assumptions; C_w at 1.1 m by profile was 24.2×10^{-3}, compared to 18.3-22.0×10^{-3} for slab. The two methods gave results which were not statistically separable and which were among the highest drags observed for sea ice. The instantaneous stress balance on the floe included contributions from material acceleration, Coriolis force, the two surface stresses, and sea-surface tilt relative to mean current and tide.

PM-036
PREISENDORFER, R. W., and C. D. MOBLEY. Data intercomparison theory. I. Minimal spanning tree tests for location and scale differences. NOAA-TM-ERL-PMEL-38 (PB83-182311), 45 pp. (1982).

When intercomparing two data sets, each of n samples of some field at p points in space, the question often arises about the relative sizes of their averages over time and about their relative variances. In this note we consider two geometric ways of answering this question. The basic geometric concept is that of a minimal spanning tree (MST) made from the union of the data sets when they are considered as n-point swarms in euclidean p-space E_p. The MST is the network of straight lines in E_p that connects the points of the pooled swarms with the least possible total length of its segments. The test of relative location of data sets based on the MST uses a generalized notion of _run_ (which measures how much the points of the two sets intermingle in their MST) while the scale test for variance is based on the simple intuitive idea that the set with greater variance will have the branches of its part of the tree spread beyond those of the other. Power tests were run for the MST location and scale tests and it was found that the MST scale test is relatively powerful and useful. An application of the MST scale test was made to the problem of defining natural seasons over the U.S. mainland using a 46-year temperature record. The result is a novel partition of the 12 months of the year into new seasons based on months with comparable temperature variances.

PM-037
PREISENDORFER, R. W., and C. D. MOBLEY. Data intercomparison theory. II. Trinity statistics for location, spread and pattern differences. NOAA-TM-ERL-PMEL-39 (PB83-184101), 91 pp. (1982).

In this report, the second in a series of five on data intercomparison theory, we examine three basic measures of data-set separation and procedures by which these measures can be assigned statistical significance. The three measures are for the distances between _means_ (SITES), _variances_ (SPRED), and _patterns_ (SHAPE) of space-time geophysical multivariate data sets. The patterns, in turn, are resolved into spatial and temporal patterns. The problem of determining procedures to generate reference distributions, by which statistical significance is decided, is resolved into five parts, depending on the amount of data available for use. We classify availability of data into five categories: _adequate, semi-adequate, borderline, semi-inadequate,_ and _inadequate._ For each of these settings we develop procedures to generate reference distributions for SITES and SPRED, and determine the power curves for these two statistics under selected procedures. These power curves are compared with those generated by some classical tests for the relative location and spread of multivariate data sets. The proposed statistics SITES and SPRED and some of their distribution-producing procedures appear to be relatively powerful and robust.

PM-038
PREISENDORFER, R. W., and C. D. MOBLEY. Data intercomparison theory. III. S-Phase and T-Phase tests for spatial pattern and temporal evolution. NOAA-TM-ERL-PMEL-40 (PB83-182329), 120 pp. (1982).

This is the third of a series of five reports on some new techniques in data intercomparison theory, devised particularly with observed and model climate data sets in mind. In this study we derive a set of statistics which describe differences in spatial patterns and temporal evolutions of data sets. These are derived from the SHAPE statistic of the second study. It is shown that SHAPE and its derivates are all of a correlational nature, thereby permitting immediate statistical significance tests using existing tables. However, it is also shown that correlation-type statistics, especially in multivariate settings, are limited in their ability to discern differences in spatial and temporal patterns of data sets. Two multiparameter tests (the S-Phase and T-Phase) are devised to remedy this limitation and their properties are given a preliminary examination. The S-Phase test is based on the canonic rotation angles between the singular value decomposition. The T-Phase test is based on the canonic correlation angles between the temporal (principal component) frames of two data sets under the same type of decomposition. These multiparameter tests, unfortunately, are difficult to interpret, even though they appear to perform well under realistic data conditions. Further multiparameter tests are devised and outlined with research programs suggested for future study. The five general procedures of the second study of the series (IOP, EOP, APP, PPP, CIP) are potential sources of reference distributions for the new multiparameter statistics.

PM-039
   PREISENDORFER, R. W., and C. D. MOBLEY. Data intercomparison theory. IV. Tercile tests for location, spread and pattern differences. NOAA-TM-ERL-PMEL-41 (PB83-182377), 45 pp. (1982).

   Two data sets can be examined for closeness by considering them as field maps and pretending that one is trying to forecast the other. This is done by applying some recently devised forecast verification techniques to the pair of data sets. The technique we apply for the purpose is the tercile (or Trinomial Stochaster) technique wherein, over a given set of points in space, the two fields have their 0-class, 1-class and 2-class errors tallied, and examined for statistical significance. These class errors can be used to gauge the closeness of the three main attributes of the data sets: their *locations* (akin to averages), *spreads* (akin to variances), and (spatial or temporal) *patterns*. In illustration, the tercile technique is applied three times: to show how to gauge the effects of different objective analysis methods on the same raw data set; to examine the self-predictability (and hence noise or information content) of a data set; and to devise a new principal-component selection rule using the concept of self-predictability.

PM-040
   PREISENDORFER, R. W., and C. D. MOBLEY. Data intercomparison theory. V. Case study: Effects of objective analysis on a tropical Pacific sea surface temperature set. NOAA-TM-ERL-PMEL-42 (PB83-182345), 79 pp. (1982).

   A study is made of an objective analysis scheme by Liu which has SST-gradient-dependent smoothing and correction operations, along with data-weight and outlier cutoff features. The scheme is an elaboration of that originally devised by Cressman and subsequently expanded by Levitus and Oort. The object of the study is to apply certain new data intercomparison techniques (developed in the four earlier works of the present series) to the data set produced by Liu's scheme, with the goal in mind to determine how the various features of the new objective analysis scheme change the location (average), scale (variance), and pattern properties of the data set. In general it is found that the *average* properties of a data set are largely unchanged by application of the above features of Liu's scheme. However, the *variance* and *pattern* properties are significantly changed by the various smoothing operations in Cressman-type objective analysis schemes. In the case of Liu's data set the changes are by amounts ($0.5°C$) that are climatologically important. Thus a new objective analysis scheme may *significantly* affect location, scale and pattern properties of a data set, and therefore in ways that could affect the formation and verification of hypotheses of climatic change.

PM-041
   REED, R. K., and R. E. Brainard. A comparison of computed and observed insolation under clear skies over the Pacific Ocean. Journal of Climate and Applied Meteorology 22:1125-1128 (1983).

   In an effort to verify computational methods for ocean heat budgets, observations of insolation under clear skies for 26 days were compared with values computed by a formula previously derived from the *Smithsonian Tables*. The agreement between the observations and formula was within 2.0% for three groups of data over the Pacific between 10°S and 47°N. Random and systematic errors in the formula appear to be insignificant in these regions, but its validity is uncertain at higher latitudes.

PM-042
REYNOLDS, M. A simple meteorological buoy with satellite telemetry. <u>Ocean</u> <u>Engineering</u> 10:65-76
(1983).

A small, inexpensive, and easily deployable meteorological buoy is described. Buoy motion is greatly
reduced by appropriate ballast techniques; vector averaging further removes buoy motion effects from wind
data. Data is transmitted to the GOES satellite and is retrieved by telephone. Measurements are
vector-averaged wind components, wind speed, wind direction, water temperature, air temperature, and
compass direction. Data from two field trials are discussed. Speed comparisons averaged 0.2 m sec^{-1}
with a standard deviation of 0.6 m sec^{-1}. Direction comparisons were different due to local topography,
but they indicate a probable accuracy of ±5°.

PM-043
Roden, G. I., B. A. TAFT, and C. C. Ebbesmeyer. Oceanographic aspects of the Emperor Seamounts region.
<u>Journal</u> <u>of</u> <u>Geophysical</u> <u>Research</u>, 87(C12):9537-9552 (1982).

Effects of the Emperor Seamount Chain on the thermohaline structure and baroclinic flow are
investigated on the basis of historical hydrographic data. The amplitudes of dynamic height
perturbations are 3 to 5 times larger west than east of the chain. The intensity of the thermal fronts
is stronger west than east of the seamounts; near the crest of the southern seamounts, strong east-west
thermohaline fronts and a strong northward baroclinic flow are observed. The Kuroshio Extension west of
the seamount chain is a well-defined meandering current, the axis of which generally lies between 33° and
36°N. The available data indicate that the Kuroshio Extension turns northward and then flows eastward
through the gaps of the seamount chain. East of the seamounts, the Kuroshio Extension widens threefold
and appears to be poorly defined.

PM-044
SALO, S. A., J. D. SCHUMACHER, and L. K. Coachman. Winter currents on the eastern Bering Sea Shelf.
NOAA-TM-ERL-PMEL-45 (PB83-248823), 53 pp. (1983).

An analysis of fifteen current records from thirteen locations over the central and northern Bering Sea
shelf is presented. Four moorings were deployed over the 1976/77 and 1977/78 winters and five over
winter 1980/81. Comparison of current and kinetic energy characteristics showed a difference between
records from north and south of St. Lawrence Island. To the north, circulation was dominated by
northward mean flow (4-15 cm/s), and tides accounted for only 24±13% of the total kinetic energy of
fluctuations. In contrast, mean currents south of St. Lawrence Island exhibited greater variation in
direction, were generally 1 to 4 cm/s in magnitude and tides accounted for about 55±31% of the
fluctuating kinetic energy. Although vector-mean currents in both regions were in general northward, and
approximately parallel to local bathymetry, frequent reversals occurred. One reversal, coincident with
northerly winds, occurred at all sites and persisted for more than two weeks; such current reversals
affect the flow over thousands of square kilometers. The presence of ice appears to affect the flow by
reducing the impact of direct wind stress as driving force.

PM-045
SAWYER, C. A satellite study of ocean internal waves. NOAA-TM-ERL-PMEL-46 (PB83-248708), 70 pp.
(1983).

Ocean internal-wave slicks over the eastern U.S. continental shelf imaged by the satellite Landsat are
described and analyzed. This study confirms generation by semidiurnal tides, locates the site of the
generation at the edge of the continental shelf, and establishes the time of generation near the time of
maximum flood current. Characteristics such as wave-packet extent, water depth, and packet lifetime are
quantitatively described. The wavelength spectrum derived from spacing of slicks observed near
generation is far from a smooth "universal spectrum." The dominant peak at 26 km corresponds to packet
spacing, and a second peak near 450 m corresponds to spacing of slicks within packets. The longest
within-packet spacing depends on total water depth. The shortest spacing changes with season and so is
probably determined by the depth of the upper warm layer. Slick visibility is discussed in terms of
modification of surface-wave amplitude by the near-surface current system of the internal waves.
Possible mechanisms are (1) damping of surface waves by film concentrated at current convergences, and
(2) damping of surface waves in a parallel current, and (3) amplification in an adverse current.
Calculations indicate that the latter mechanism provides a better quantitative description of the
observed contrast between slicks and rough bands. Though the derived dependence on sun altitude and
windspeed corresponds to some observed characteristics, the simplified theory and average parameters used
in this trial application only partially explain the observed latitude distribution of visible slicks.
From uniformly spaced series of packets, and from similar packet images recorded on successive days, the

median lifetime of slick packets is found to be two to three tidal cycles, much longer than the time in which waves are expected to disperse or to break. The balance of non-linear terms in the cnoidal solution of the Korteweg-de Vries equation that permits a stable wave profile relates amplitude and wave number in terms of the elliptic parameter, m. Solutions progress from a train of sinusoidal waves at $m = 0$, through trains of waves with flat crests and widely separated troughs, to the solitary wave of infinite length at $m = 1$. The cnoidal solution describes the stability and other observed features of the internal waves, but the variable spacing of slicks within a packet demands a more complex description.

PM-046
SAWYER, C. Tidal phase of internal-wave generation. <u>Journal</u> <u>of</u> <u>Geophysical</u> Research 88:2642-2648 (1983).

The tidal phase at which ocean internal waves are generated is examined by using two sets of data. The first data set, consisting of 21 time series of internal-wave packets located with respect to the continental shelf edge on satellite images, clearly indicates generation near flood tide. In the second data set, observations of thermal oscillations shoreward of a sill can be modeled either as generated shortly after ebb tide on the seaward side of the sill or slightly before flood on the shoreward side. The absence in both sets of observations of evidence of internal waves over the sill or seaward of the sill points to flood generation at the sill as well as at the shelf. The shelf edge is found to be the most likely site of tidal generation of internal waves observed over the shelf.

PM-047
SCHOENBERG, S. A. Regional wind patterns of the inland waters of western Washington and southern British Columbia. NOAA-TM-ERL-PMEL-43 (PB83-207969), 61 pp. (1983).

This study generalizes a time series of regional wind fields in an area of strong topographic influence. Wind speed and direction measured by 6 meteorological buoys and 1 tower anemometer were used in addition to routinely available surface observations. The data were measured during the last three weeks of February and the first week of March in 1980 when the region's upper-level flow was dominated by a quasi-stationary ridge, which broke down midway and again in the last 5 days of the period to allow passage of small-amplitude troughs. The 850-mb wind direction measured at Quillayute, Washington, was chosen as an indicator of synoptic-scale flow uninfluenced by the topography. The directions measured at 12-hour intervals were divided into 11 classes of 30° each. The corresponding surface wind fields were then grouped, and the resultant vector and persistence fields were mapped for each class. The 11 wind field composites showed that while the wind field varied in a regular fashion as the synoptic-scale flow varied, Bernoulli-type down-pressure-gradient flow in restricted channels and geostrophy both operated as balancing mechanisms to the imposed synoptic-pressure gradient in different areas simultaneously. As the 850-mb wind became parallel to the Strait of Georgia and Puget Sound, 140°-190°, and then shifted to the west, the surface wind fields abruptly shifted from primarily an east-west orientation to a north-south orientation. In the absence of a pressure gradient between Port Hardy, B.C., and Portland, Oregon, of greater than 3 mb, a diurnal wind circulation was observed in the eastern Strait of Juan de Fuca, the southern Strait of Georgia, and Puget Sound.

PM-048
SCHUMACHER, J. D., K. Aagaard, C. H. PEASE, and R. B. Tripp. Effects of a shelf polynya on flow and water properties in the northern Bering Sea. <u>Journal</u> <u>of</u> <u>Geophysical</u> Research 88:2723-2732 (1983).

We present long-term (~230-day) measurements from three moorings in the vicinity of Saint Lawrence Island on the northern Bering Sea shelf. One mooring was deployed near the polynya which often exists south of the island. These data confirm the existence of strong (~0.15 m s^{-1}) flow toward Bering Strait northwest of the island (in Anadyr Strait) and suggest that regional circulation results in a moderate (~0.035 m s^{-1}) mean flow eastward along the southern coast of Saint Lawrence Island. Coherent variations in the regional circulation and variations in the geostrophic wind account for much of the low-frequency current fluctuation south of Saint Lawrence Island. However, there were 11 events when offshore (northerly) winds coincided with the temperature following the freezing point, increasing salinity, and reversal of the current. This suggests that ice formation and the ensuing brine rejection affect flow in the vicinity of the polynya. Scaling of a simplified momentum equation indicates that the cross-shelf density gradient was a possible mechanism for some of the reversals. Salinity data show a seasonal cycle as well as individual events of brine rejection. During an average event time of 65 hours, the salinity increased by 8×10^{-3} g kg^{-1} h^{-1}; the heat flux can be estimated as 535 Wm^{-2}. These fluxes correspond to an ice production of ~5 m during winter 1981. Extrapolation of our results and comparison with the freshwater cycle suggest that brine rejection is an important component of the regional salt budget.

PM-049
SCHUMACHER, J. D., and T. H. Kinder. Low-frequency current regimes over the Bering Sea Shelf. Journal of Physical Oceanography 13:607-623 (1983).

Using direct current measurements made during the period 1975-81, we describe the general circulation over the southeastern Bering Sea and differentiate it by regimes related to depth and forcing mechanisms. Three regimes are present, delineated by water depth (z): the coastal ($z \leq 50$ m), the middle shelf ($50 < z < 100$ m), and the outer shelf ($z \geq 100$ m). These are nearly coincident with previously described hydrographic domains. Statistically significant mean flow (~ 1 to 10 cm s^{-1}) exists over the outer shelf, generally directed toward the northwest, but with a cross-isobath component. Flow of similar magnitude (1-6 cm s^{-1}) occurs in the coastal regime, paralleling the 50 m isobath in a counterclockwise sense around the shelf. Mean flow in the middle shelf is insignificant. Kinetic energy at frequencies < 0.5 cycle per day (cpd) is greater over the outer shelf than in the other two regimes, suggesting that oceanic forcing is important there but does not affect the remainder of the shelf. Kinetic energy in the band from 0.5 to 0.1 cpd follows a similar spatial pattern, reflecting the greater number of storms over the outer shelf. Mean flow paralleling the 100 and 50 m isobaths appears to be related to a combination of baroclinic pressure gradients (associated with frontal systems which separate the regimes) and interactions of tidal currents with bottom slopes located beneath the fronts. Although winds are energetic and they result in higher values of kinetic energy during winter, their highly variable behavior suggests that they are not a primary driving force for mean flow.

PM-050
SCHUMACHER, J. D., and P. D. MOEN. Circulation and hydrography of Unimak Pass and the shelf waters of the Alaska Peninsula. NOAA-TM-ERL-PMEL-47 (PB83-257006), 75 pp. (1983).

We present wind, current, bottom pressure, and hydrographic observations from Unimak Pass and the adjacent shelf. Mean flow was from the Gulf of Alaska into the Bering Sea and resulted from the Kenai Current. Shorter period fluctuations were bi-directional and coherent with divergence along the coast. Observations along the northern side of the Alaska Peninsula indicated Kenai Current water had an impact on the local salt content in the coastal domain, and together with freshwater discharge maintained a stronger horizontal density gradient in the vicinity of the 50-m isobath. Associated with this front was a moderate (1 to 6 cm/s) mean flow. Wind forcing, manifested both as coastal divergence and as a source of strong mixing, was evident at shorter periods. Results substantiated previous studies, but they also revealed subtle features including impact of freshwater discharge not associated with gaged rivers, importance of gaps in the mountains to the generation of pressure gradient winds, and the nature of processes which destroy and establish the inner front and the typically two-layered middle shelf domain structure.

PM-051
Thompson, T. W., D. E. Weissman, and F. I. GONZALEZ. L band radar backscatter dependence upon surface wind stress: a summary of new SEASAT-1 and aircraft observations. Journal of Geophysical Research 88:1727-1735 (1983).

Radar backscatter from the ocean depends on surface wind stress for a wide range of radar wavelengths. Here, we have reviewed the wind-radar relationships for L band radar wavelengths near 25 cm and 20° angle of incidence and HH polarization using a number of aircraft and SEASAT-1 SAR observations. At this wavelength, the L band backscatter coefficient (σ^o) from the ocean appears to depend upon surface wind speed ($|\vec{U}|$) and direction (ϕ) in the following manner: $\sigma^o = K|\vec{U}|^a[1 + b \cos (2\phi)]$. The wind-speed coefficient a is 0.5 ± 0.1 for a wide range of wind speeds. The wind-direction coefficient b is near zero (i.e., $b = 0.05 \pm 0.05$) for lower winds and stable marine boundary layers. However, one unusual aircraft observation suggests that $b = 0.20 \pm 0.05$ for moderate wind speeds and an unstable marine boundary layer. We have examined a variety of aircraft and SEASAT-1 observations. SEASAT synthetic aperture radar (SAR) observations in conjunction with simultaneous SEASAT scatterometer measurements provide an excellent measurement of the wind-speed coefficient a since a variety of wind speeds can be observed in a few minutes. Aircraft observations provide an excellent measurement of wind-direction coefficient b since a number of directions can be examined in about 1 hour with special flight patterns designed for multiple look directions. Thus, both aircraft and spacecraft observations were studied in this work. We have interpreted these aircraft and spacecraft results in terms of existing theoretical models for radar scattering from the ocean. We believe that modulation of echo power by the magnitude of the wind occurs through both large-scale slope effects as well as through growth of the short gravity wave-height spectrum. Our data is near an angle of incidence of 20° where a two scale scattering model must be used.

PM-052
WALTER, B. A., JR., and J. E. OVERLAND. Response of stratified flow in the lee of the Olympic
Mountains. Monthly Weather Review 110:1458-1473 (1982).

The behavior of stratified air flowing around an isolated mountain is dependent on an internal Froude
number (F), which indicates the relative importance of upstream velocity and vertical stratification.
Three cases of the flow in the lee of the Olympic Mountains in the State of Washington are studied where
the measured F was in the range 1.0-1.4 but apparently dominated by stable stratification. This study
combined measurements of spatial variation of low-level winds and other parameters from a NOAA P-3
research aircraft with a dense network of surface stations including eight meteorological buoys and six
upper-air stations. Results from these cases show the presence of an area of light winds in the lee of
the Olympic Mountains. The characteristics of the flow are shown to be similar to laboratory results for
low Froude number flow around an isolated obstacle where the flow is confined to quasi-horizontal planes.
These cases are contrasted with a situation which led to the formation of a mesoscale low-pressure area
and high surface winds in the lee of the mountains. The latter case was the Hood Canal Bridge storm on
13 February 1979 where local winds in the lee of the Olympic Mountains were in excess of 50 m s^{-1}. The
flow at the surface was produced by down-pressure-gradient acceleration in the confined channels of Puget
Sound toward the orographically produced low-pressure center. The measured internal Froude number in
this situation was 4.6, and the pressure fields are shown to agree with the linear hydrostatic model
developed by Smith (1980) for F > 1. It is suggested that the Froude number calculated from routine,
upper-air sounding data is an index that forecasters can use to determine the potential for severe wind
conditions over the inland waters of Puget Sound.

PM-053
Weller, R. A., and D. HALPERN. The velocity structure of the upper ocean in the presence of surface
forcing and mesoscale oceanic eddies. Philosophical Transactions of the Royal Society of London
308:327-340 (1983).

One goal of the Joint Air-Sea Interaction Experiment (JASIN) was to investigate the structure of the
near-surface velocity field and to attempt to quantify what fraction of that field was related to the
local wind. Toward that end, in the late summer of 1978, two moorings were deployed in the northern
Rockall Trough with oceanographic instrumentation concentrated in the upper 100 m of the ocean.
Simultaneous observations were made of the surface winds at each mooring and, adjacent to one of the
moorings, of the velocity field at depths from 79 to 1000 m. Energetic, eddy-like circulation dominated
the velocity field in the JASIN area at depths shallower than approximately 800 m. However, both the
velocity and the vertical shear of the horizontal velocity showed variability that increased with
proximity to the surface. Empirical orthogonal functions, computed to separate the velocity data into
uncorrelated modes of variability, showed that over 97% of the variability in the upper 300 m was
distributed among only three vertical modes. The first function had little depth dependence; the second
had strong depth-independent flow in the depth range of the mixed layer and weak flow in the opposite
direction at all depths below; and the third had strong flow near the surface, strong flow in the
opposite direction just below the base of the mixed layer, and weaker flow at all other depths. Function
1 alone provided a near-complete description of the velocity variability below 85 m, where the flows
associated with the eddy-like circulation and the barotropic semidiurnal tide were the dominant
components. At 85 m and above all three functions were necessary to provide a complete description.
Temporal variability of function 2 was coherent with the local wind stress at the inertial frequency,
but, at lower frequencies, resulted in transport in the mixed layer to the southeast that was not
coherent with the local wind. Low frequency temporal variability of function 3 was coherent with the
local wind stress; at these frequencies the velocity vector of function 3 nearest the surface was
directed to the right of the wind stress vector and the velocity vector just below the base of the mixed
layer was directed to the left of the wind stress. Thus, forcing by the local wind can account for some
but not all of the increased variability found near the surface.

PM-054
WRIGHT, P. B. Sea surface temperature fluctuations in the Pacific, 0°-50°N. Tropical Ocean-Atmosphere
Newsletter, 19:14-15, July (1983).

No abstract.

PM-055
WRIGHT, P. B. Sea surface temperature patterns in the equatorial Pacific. Tropical Ocean-Atmosphere
Newsletter 20:15-16, September (1983).

No abstract.

PM-056
   YOUNG, A. W., and J. D. CLINE. Super-speed centrifugation at sea using a gimballed platform.
   Estuarine, Coastal and Shelf Science 16:145-150 (1983).

   The use of a super-speed centrifuge at sea for the recovery of suspended solids or interstitial pore
fluids requires a stabilizing platform. In this report, we describe a simple platform gimball and
magnetic rotor stabilizer that have been fitted to a Sorvall model SS-3 super-speed centrifuge. In
principle, any centrifuge of comparable weight (86 kg) could be easily adapted for use at sea with
gimbals of similar design. The magnetic rotor coupler is designed to eliminate rotor precession when the
centrifuge is operated at sea. This attachment is particularly useful when the Sorvall SS-3 (equipped
with a conventional rotor) is used to recover interstitial pore fluids.

RF-001
  DEVIVO, R. J. Development of techniques for the calibration of radiation thermometers and pressure
  transducers. Preprints, Fifth Symposium on Meteorological Observations and Instrumentation, April
  11-15, 1983, Toronto, Ont., Canada. American Meteorological Society, Boston, 397-401 (1983).

  No abstract.

RF-002
  EMMANUEL, C. B. The NOAA WP-3D meteorological research aircraft. Preprints, Fifth Symposium on
  Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Ont., Canada. American
  Meteorological Society, Boston, 216-221 (1983).

  No abstract.

RF-003
  GOLDSTEIN, A. S., and J. D. DUGRANRUT. An aircraft satellite data link. Preprints, Fifth Symposium on
  Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Ont., Canada. American
  Meteorological Society, Boston, 243-245 (1983).

  No abstract.

RF-004
  HAYDU, K. J., and E. R. DARBY. Description and operating procedures for the NOAA C-130 AWRS system.
  NOAA-TM-ERL-RFC-11 (PB83-197053), 55 pp. (1983).

  No abstract.

RF-005
  MERCERET, F. J. An empirical study of HF air to ground communications at the Research Facilities
  Center based on radio logs. NOAA-TM-ERL-RFC-12 (PB83-222588), 43 pp. (1983).

  Radio logs documenting HF air to ground radio transmissions between the RFC and its aircraft are exam-
  ined for frequency usage. A wide range of frequencies is necessary to maintain reliable communications.
  Certain frequencies are shown to be more useful than others at certain ranges and times of day. Details
  are given.

RF-006
  MERCERET, F. J. First order autoregressive low-pass filters: a user's quick reference handbook.
  NOAA-TM-ERL-RFC-9 (PB83-189456), 25 pp. (1983).

  A collection of formulas, charts and tables describing the properties of first order autoregressive
  low-pass filters is presented. The collection is structured for utility rather than mathematical
  sophistication. It provides a quick reference for those using these simple digital low-pass filters.
  The response characteristics are presented in both the time and frequency domains, and problems associ-
  ated with record length and initialization are discussed.

RF-007
  MERCERET, F. J. The sensitivity of variables computed from RFC WP3D flight data to fluctuations in
  the raw data inputs. NOAA-TM-ERL-RFC-8, (PB83-169987), 43 pp. (1983)

  This paper presents an investigation of the sensitivity of the meteorological data obtained by RFC to
  variations in each of the raw data inputs. Each NOAA/RFC WP3D weather reconnaissance aircraft directly
  measures 16 raw quantities with its main meteorological data system. From these, 29 functions (includ-
  ing intermediate values) are computed yielding the standard meteorological and navigational quantities
  used for research. Of the 464 possible sensitivity coefficients, 123 are non-zero. Analytical
  expressions are derived for most non-zero coefficients, and for all coefficients numerical values under
  typical operating conditions are determined.

The results presented here may be used to estimate the effect of noise or errors in the input signals on the resulting outputs. The critical determinants of any output may be found, thus facilitating isolation of primary error sources when problems are detected in the final data.

RF-008
PARADIS, K. A. Research aircraft measurement system operations manual. NOAA-TM-ERL-RFC-10 (PB83-197061), 87 pp. (1983).

The NOAA Research Facilities Center (RFC) Lockheed WP-3D research aircraft have each been equipped with a computer-based data acquisition system. The primary use for this system is to collect and record the meteorological, oceanographic, and positional data provided by the various sensors and navigation equipment mounted on or expelled from the aircraft. In addition, these data are selectively analyzed and displayed in real-time by the graphics system. Together, these two systems and the attendant hardware form the Research Aircraft Measurement System (RAMS). This report offers a basic explanation of the operation and application of RAMS.

RF-009
PARADIS, K. A., and F. J. MERCERET. Sampling, decimation, and other sources of spectral error in digital RFC WP-3D aircraft data. Preprints, Fifth Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Ont., Canada. American Meteorological Society, Boston, 296-302 (1983).

No abstract.

SE-001
   Ahn, B.-H., S.-I. Akasofu, Y. KAMIDE. The Joule heat production rate and the particle energy injection rate as a function of the geomagnetic indices AE and AL. Journal of Geophysical Research 88:6275-6287 (1983).

As a part of the joint efforts of operating six meridian chains of magnetometers during the IMS, magnetic records from 71 stations are used to deduce the distribution of electric fields and currents in the polar ionosphere for March 17, 18, and 19, 1978. As a continuation of this project, we have constructed hourly distribution maps of the Joule heat production rate, the particle energy injection rate and their sum over the entire polar region on the three days. For this purpose the conductivity distribution is inferred at each instant partially on the basis of an empirical method devised by Ahn et al. (1982). The particle energy injection rate is estimated similarly by using an empirical method. The data set thus obtained allows us to estimate also the global Joule heat production rate U_J, the global particle energy injection rate U_A and the sum U_I of the two quantities. It is found that the three global quantities (watt) are related almost linearly to the AE(nT) and AL(nT) indices. Our present estimates give the following relationships: U_J = 2.3 times 10^8 · AE, U_A = 0.6 times 10^8 · AE and U_I = 2.9 times 10^8 · AE; U_J = 3.0 times 10^8 · AL, U_A = 0.8 times 10^8 · AL, and U_I = 3.8 times 10^8 · AL.

SE-002
   Ahn, B.-H., R. M. Robinson, Y. KAMIDE, and S.-I. Akasofu. Electric conductivities, electric fields and auroral particle energy injection rate in the auroral ionosphere and their empirical relations to the horizontal magnetic disturbances. Planetary Space Science 31(6):641-653 (1983).

Recent progress in modeling ionospheric current systems requires global conductivity models which can reflect substorm conditions on an instantaneous basis. For this purpose, empirical relations of the North-South component (ΔH) of the magnetic disturbance field observed at College with the Pedersen (Σ_p) and Hall (Σ_H) conductivities deduced from the Chatanika radar data and their ratio (Σ_H/Σ_p) are examined. These empirical formulas allow us to construct approximate distribution patterns of Σ_p and Σ_H over the entire polar region on the basis of the distribution of ΔH at given instants by devising an appropriate weighting function for both the polar cap and the subauroral region. The global conductivity distributions thus obtained are compared with those employed by Kamide et al. (1981) and Spiro et al. (1982). The comparisons show that the gross features are similar among them. In addition, we also examine the relationship of ΔH with the North-South component of the electric field with the particle energy injection rate (u_A) estimated from the Chatanika radar data. Based on the empirical relation between Σ_H and u_A the global distribution of the latter over the entire polar region at particular instants can also be obtained.

SE-003
   Akasofu, S.-I., B.-H. Ahn, Y. KAMIDE, and J. H. Allen. A note on the accuracy of the auroral electrojet indices. Journal of Geophysical Research 88(A7):5769-5772 (1983).

The accuracy of the present AE (12) index is evaluated by using magnetometer data from the six IMS meridian chains and other high-latitude stations. It is shown that the accuracy of AE(12) becomes progressively worse for lower values. There are at least a few causes for this inaccuracy, and three of them are identified. Although it is not possible to provide a single critical value, one should be cautious about the accuracy of the absolute value of AE(12) less than ~250 nT. In particular, since 70% of AE(12) values are less than 250 nT, one must be cautious in correlative use of the AE(12) index with solar wind parameters.

SE-004
   ANDERSON, D. N. Modeling the ambient, low latitude F-region ionosphere--a review. Journal of Atmospheric and Terrestrial Physics 43(8):753-762 (1981).

This paper describes some recent theoretical modeling efforts which primarily study the effects of ExB drift, both vertical and horizontal, on the equatorial ionosphere. Solving the time-dependent ion continuity equation for plasma densities as a function of altitude, latitude and local time it is shown that: (1) by incorporating F-region, vertical ExB drifts which are typical of solar cycle maximum and minimum equinoctial conditions, good agreement is achieved between observed and calculated foF2 values at the magnetic equator (American sector) for these two periods. (2) Modeling the seasonal anomaly in foF2 at Kodaikanal for October 1975 and July 1976 requires different vertical ExB drift patterns for these two

months and both of these patterns are significantly different from the drifts measured at Jicamarca. (3) By incorporating a realistic ExB drift model which includes the post-sunset enhancement in upward drift, bottomside F-region electron density scale heights are found to be in good agreement with measured values in the 1900-2400 LT period. (4) When a realistic east-west ExB drift pattern is included, calculated electron density profiles at the magnetic equator between 1800 and 2400 LT do not differ significantly from calculated profiles obtained when this component of ExB drift if omitted.

SE-005
ANDERSON, D. N., A. D. RICHMOND, B. B. BALSLEY, R. G. Roble., M. A. Biondi, and D. P. Sipler. In-situ generated gravity waves as a possible seeding mechanism for equatorial spread-F. Geophysical Research Letters 9(7):789-792 (1982).

Recent observations have shown that prior to the onset of equatorial spread-F, there exists an altitude modulation in bottomside F-region electron density contours. It has generally been accepted that such a modulation is caused by internal-gravity waves propagating upward from below. In this brief note we suggest that gravity waves may be generated in situ, via the wind shear mechanism. Theoretical calculations indicate that large wind shears can occur during early evening hours in the low latitude thermosphere. We show that the wind shear may possibly generate gravity waves with horizontal wavelengths on the order of a few hundred kilometers, which is the scale of the observed electron density modulation.

SE-006
ANDERSON, D. N., and R. G. Roble. Neutral wind effects on the equatorial F-region ionosphere. Journal of Atmospheric and Terrestrial Physics 43(8):835-843 (1981).

The winds and temperatures calculated by the NCAR thermospheric general circulation model (TGCM) for equinox and solstice conditions are used to investigate their effect on the low-latitude ionospheric F-region. Calculated values of foF2 are compared with observed values at two stations, Huancayo, Peru (1°N dip latitude), and Tucuman, Argentina (11° dip latitude).
The results show that during the solar cycle maximum equinoctial period good daytime agreement is obtained between calculated and observed foF2 values at Huancayo, Peru, and at Tucuman, Argentina. Nighttime agreement at Tucuman is not as good, suggesting that the observed ionospheric behaviour may be responding to dynamics associated with the midnight temperature bulge at low latitudes. The wind calculation by the TGCM consider only in situ thermospheric forcing and the results indicate that upward-propagating tides from the lower atmosphere are important for describing both thermospheric and ionospheric dynamics at low latitudes. During the December solstitial period, agreement between caculated and observed values at both Juancayo and Tucuman is improved when the wind fild is included in the calculations. However it is still necessary to include the dynamics associated with the midnight temperature bulge to obtain good agreement between the calculated and observed values of foF2.

SE-007
BOUWER, S. D., R. F. DONNELLY, J. FALCON, A. QUINTANA, G. CALDWELL. NOAA-TM-ERL-SEL-62 (PB83-118174), 71 pp. (1982).

The 1-8Å band of synodic full-disc solar x-rays (1-8Å) $W \cdot m^{-2}$ have been measured nearly continuously from 1975 to 1981 aboard the SMS-1, SMS-2, GOES-1, GOES-2, and GOES-3 satellites. These measurements are scheduled to continue in an on-going series of GOES satellites. The 1-8Å band of x-rays are proportional to the emission measure at coronal heights at temperatures greater than 2×10^6 K. In the past, attention has been centered on using solar x-ray measurements in the detection and description of solar flares and their ionospheric effects. Here we center on a practical method of describing solar 1-8Å mean and background x-ray measurements in a continuous time series to describe long-term solar variability. Intercomparisons of the satellites using linear regression techniques and a useful background coronal index are described. Sources of error and statistical information on relative accuracy are discussed. Data are presented in monthly plots of hourly averages, in tables of daily mean and background indices, and in comparison to the Ottawa 10.7 cm radio flux.

SE-008
CESSNA, J. R., R. B. Hoover, R. N. GRUBB, P. L. ORSWELL, J. H. TAYLOR. The GOES X-Ray imager feasibility demonstration. NOAA-TR-ERL-423-SEL-41 (PB83- N/A), 86 pp. (1983).

The major components of an X-ray and EUV imager suitable for operational use on the NOAA Geostationary Operational Environmental Satellites (GOES) were fabricated and tested. The design and fabrication techniques used for the X-ray mirror are described. Results are given for both X-ray and visible-light tests of the mirror and a charge coupled device (CCD) imaging detector. These include the successful demonstra-

tion of image "despinning," i.e., the integration of an image moving across the detector to increase integration time and therefore sensitivity. This technique would be necessary to design a practical instrument for use on a spin-stabilized spacecraft such as the present GOES satellite.

SE-009
  Cliver, E. W., S. W. Kahler, P. S. McINTOSH. Solar proton flares with weak impulsive phases. The Astrophysical Journal 264:699-707, (1983).

The current picture of a proton flare includes a well-defined impulsive phase characterized by a prominent hard X-ray (or microwave) peak. Lin and Hudson have argued that the correlation between intense flare hard X-ray bursts and large proton events is evidence that the second stage of particle acceleration, during which the protons observed at 1 AU are thought to be accelerated, is fueled by energy originally contained in flash phase 10-100 KeV electrons. In our examination of large (J[>10 MeV] $\leq$10 protons cm^{-2} s^{-1} sr^{-1}), prompt, proton events occurring between 1965-1979, however, we found several events that originated in flares with relatively weak (Sp[9 GHz]<100 sfu) impulsive phases. Various lines of evidence indicate that these flares were associated with mass ejection events which, given the absence of a prominent flash phase, appear to have been magnetically driven.

SE-010
  Cuperman, S., I. Weiss, and M. DRYER. Generalized expressions of momentum and energy losses of charged particle beams in non-Maxwellian multi-species plasmas and spherical symmetry. Journal of Plasma Physics 28(3):445-457 (1982).

Generalized expressions for the rates of change of the momentum, energy and thermal anisotropy of fast, charged particle beams interacting with non-Maxwellian multi-species plasmas are derived. The results hold for the case of spherically symmetric systems and, therefore, are relevant for inertial confinement fusion schemes driven by fast charged particle beams and for various astrophysical situations. The calculations are based on the Fokker-Planck formalism. The effects connected with the departures from the Maxwellian distribution functions are expressed in terms of their fifth moments, $\zeta_1 \equiv \int (v_r - \langle v_r \rangle)^4 f_1 dv$, which reflect the role of the non-Maxwellian tails. The familiar stopping power expression holding for Maxwellian targets is recovered as a particular case.

SE-011
  Cuperman, S., I. Weiss, and M. DRYER. A variational derivation of the velocity distribution functions for nonequilibrium, multispecies, weakly interacting, spherically symmetric many-body systems. Journal of Statistical Physics 29(4):803-812 (1982).

The most probable velocity distribution function of each component, f_a, of a nonequilibrium multispecies spherically symmetric system of particles (stellar plasma atmospheres and winds, stellar systems, pellet-fusion systems) is analytically dervied for the case in which each component is described by the first six moments of f_a. This is achieved by the aid of a variational approach based on the requirement that a Boltzmann H function for the system be a minimum subject, to the constraints provided by the sets of six macroscopic parameters describing the nonequilibrium state. The use of the so-obtained velocity distribution functions for the closure of the moment equations as well as for the calculation of their collisional terms (via the Fokker-Planck equation) is discussed. The limitations on the maximum deviations from the equilibrium state which are consistent with the assumptions used are also indicted.

SE-012
  DAVIES, K. Atmospheric gravity waves produced by solar eclipses--a review. Total Solar Eclipse of 16 February 1980, Proc. Indian National Science Academy, 48,A, Sup. 3:342-355 (1982).

The paper reviews the theoretical and experimental bases for gravity wave production resulting from cooling produced by the moon's shadow. Theoretically, it is reasonable to expect waves from the low shock after propagation in a dispersive and anisotropic atmosphere and that focusing should be expected from the eclipse geometry. Experimental evidence from the eclipses of 7 March 1970 in North America, 30 June 1973 in Africa and 23 October 1976 in Australia leave doubts as to whether such waves have been observed.

SE-013
  Devara, P. C. S., M. I Ahmed, M. Srirama Rao, and B. Ramachandra Rao. Meteor wind radar studies at Waltair. Indian Journal of Radio & Space Physics, 10:228-236 (1981). NOAA Contract Report.

Various results obtained since the middle of June 1979 by a meteor wind radar system developed at Nagarampalem field station, Waltair (geogr. lat., 17°43'N; long. 83°18'E) for studying neutral winds in the altitude range 80-110 km, are reviewed. The signal-to-noise ratio (p_p/p_n) computations for the system reveal that the meteor trails with critical line density of 24 x 10^{14}/m give values of 42-52 dB for transmitter powers of 2.5-20 kW. The radio meteor echo data observed on both shower and non-shower periods exhibited diurnal variation with early morning peak and evening dip. The echo duration and diffusion coefficient measurements show that the most probable echo duration is 0.06 sec while the diffusion coefficient ($\log_{10}$ D) is varying 5.5 cm^2/sec. The diurnal variation of the diffusion coefficient depicts a broad maximum during morning hours and a broad minimum during evening hours. A least square Fourier analysis of the wind observations showed the dominance of the diurnal component for most of the time over the other components of the tidal spectrum. The prevailing component is observed to vary from 6 to 25 m/sec for zonal wind and from 0.2 to 18 m/sec for meridional wind. The day-to-day variability in the phase of diurnal and semidiurnal components is found to be much higher for the zonal wind than for the meridional wind. Long period wind oscillations with periodicities between 2 and 5 days are observed and their association with the pressure and temperature variations at the earth's surface has been explained.

SE-014
DONNELLY, R. F., A. Baker-Blocker, S. D. Bouwer, J. Lean. NOAA-TM-ERL-SEL-64 (PB   N/A   ). 80 pp. (1982).

Research of the temporal variations of solar ultraviolet radiation is reviewed. Progress on a collaborative program to analyze Dr. D. F. Heath's NIMBUS-7 SBUV measurements of the solar UV spectral irradiance is summarized. Significant progress has been made on determining the wavelength and temporal characteristics of UV variations caused by solar active region evolution (birth, growth, peak, decay and occasionally rejuvenation) and by solar rotation (area foreshortening, center-to-limb darkening and limb occultation). Work on trying to corroborate an observed semiannual UV variation has commenced. Extensive progress on modeling solar UV variations has been achieved. Support for improved rocket-flight measurments of solar UV spectral irradiance is discussed. The importance of obtaining accurate recalibration is stressed. Recalibration flights are needed to permit accurate intercomparison of the NIMBUS-7 solar UV measurements at the maximum of solar cycle 21 with the SUBV/2 measurements planned for the upcoming solar minimum and for solar cycle 22.

SE-015
DRYER, M. Coronal transient phenomena. Space Science Reviews 33:233-275 (1982).

Solar coronal transients, particularly those caused by flares and eruptive prominences, play a major role in the fields of solar-terrestrial physics and astrophysics. In the former field, coronal transients and their associated interplanetary disturbances are responsible for solar and galactic cosmic ray modulations, as well as planetary magnetospheric and ionospheric disturbances. In the latter field, supernovae remnants are scaled-up manifestations of such disturbances; that is they are stellar, rather than solar, coronal transients. Study of the more accessible solar transients is proving invaluable in both fields and is, therefore, selected for attention in this paper.
A series of coronal transient observations is discussed in the spirit of a representative overview following some introductory remarks on the background solar wind. One of these observations is chosen because its interplanetary signature--the shock wave--was detected by two spacecraft at different heliocentric radii. Other cases are chosen because of the extended observations of embedded eruptive prominences. Progress is also being made in the interdisciplinary areas of optical imagery complemented with radio astronomical techniques.
Finally, several recent theoretical models and MHD computer simulation studies are summarized. It is suggested that further comparison of specific events with such models promises a rich harvest of physical understanding of the origin, structure and interplanetary progeny of coronal transients.

SE-016
DRYER, M. Study of travelling interplanetary phenomena. In Advances in Space Research, Solar Maximum Year 2(11):7-8 Pergamon Press (1982).

No abstract.

SE-017
DRYER, M., H. Perez-de-Tejada, H. A. Taylor, Jr., D. S. Intriligator, J. D. Mihalov, and B. Rompolt. Compression of the Venusian ionosphere on May 20, 1979, by the interplanetary shock generated by the solar eruption of May 8, 1979. Journal of Geophysical Research 87:9035-9044 (1982).

An interplanetary shock wave that was produced by a solar eruption and its associated coronal transient on May 8, 1979, has been 'tracked' through interplanetary space to a rendezvous 2 days later with Venus. The interaction of the shock wave with the ionospheric obstacle at Venus produced a significant compression of the dayside ionosphere. It is believed that the tracking, as it were, was accomplished for the first time via the diagnostic observations provided by H_α and white light imagery near the sun and the plasma and field measurements of two, nearly radially aligned, spacecraft.

SE-018
  DRYER, M., R. S. Steinolfson, Z. K. Smith. Theoretical MHD simulations of coronal transients and interplanetary observations. Proceedings of the STIP Symposium on Solar Radio Astronomy, Interplanetary scintillations and coordination with spacecraft. AFGL-TR-82-0390, Space Physics Division, Air Force Geophysics Laboratory, Hanscom AFB, MA. 01731; 137-151 (1982).

A major long-range goal of theoretical simulations of solar-generated disturbances (transients, coronal holes, etc.) is the realistic modeling of a propagating disturbance from the sun into and throughout interplanetary space. Simulations of this kind, using MHD fluid theory, must always be confronted with observations in order to assess the degree to which one or the other is inadequate. We describe some of this on-going work which is concerned with both one- and two-dimensional, time-dependent MHD simulations.
  The first example of such work begins with the simulation of a flare-produced coronal transient. In this case, a sudden current pulse is assumed to produce emerging magnetic flux. This "magnetic pulse" is sufficient to drive a weak shock wave into the solar wind by virtue of an outwardly-directed Lorentz force. Explicitly the pulse is assumed to consist of a linearly-increasing (with time) magnetic field of 0.72 G at the base of a closed magnetic topology (initially in hydrostatic equilibrium) to a value ten times larger than over a 10-minute period. The shock achieves a velocity of 230 km s^{-1} (which would be superimposed upon the existing solar wind).
  A second example is concerned with a series of corotating interaction regions which were observed during a 60-day period by Pioneers 10 and 11 in 1973 prior to, during, and subsequent to the former spacecraft's flyby of Jupiter. An opportunity for a stringent test of our one-dimensional model was made possible by the nearly radial alignment of these two spacecraft. By using the upstream spacecraft data as input into the time-dependent MHD model, we obtained a simulation of the solar wind plasma and magnetic field data that were measured by Pioneer 10 at that planet.
  These examples dramatically illustrate the need for extensive observational information at the inner boundary in order to assess the validity of any comprehensive, self-consistent theoretical model. The second example dramatically illustrates the desirability of using actual data for both input and downstream comparison in order to assess the validity of a relatively straightforward, yet comprehensive,

SE-019
  DRYER, M., and S. T. Wu. Magnetohydrodynamic modelling of interplanetary disturbances between the sun and the earth. Space Physics Divsiion, Air Force Geophysics Laboratory, Hanscom AFB, MA 01731, AFGL-TR-82-0396 (1982).

A time-dependent, nonplanar, two-dimensional (2-D) magnetohydrodynamic computer simulation model is used to simulate a series of solar flare-generated shock waves and their subsequent disturbances in interplanetary space between the sun and the earth's magnetosphere. The "canonical" or anzatz series of shock waves include initial velocities near the sun over the range 500 to 3000 km sec^{-1}. The ambient solar wind, through which the shocks propagate, is taken to be a steady-state flow that is independent of heliolongitude; its radial dependency consists of a representative set of plasma and magnetic field parameters which will be presented.
  Particular attention is directed to the MHD model's ability to address fundamental operational questions regarding the long-range forecasting of geomagnetic disturbances. These questions are: (1) will a disturbance (such as the present canonical series of solar flare shock waves) produce a magnetospheric and ionospheric disturbance, and, if so; (2) when will it start; (3) how severe will it be; and (4) how long will it last? The model's output is used to compute various solar wind indices of current interest for this purpose.
  It is concluded that future work should be focused on a cohesive updating of, for example, daily measured solar parameters as input for the model whose output should be compared with spacecraft data for specific events.

SE-020
  Engebretson, M. J., L. J. Cahill, Jr., and D. J. WILLIAMS. Pulsations in magnetic field and ion flux observed at L = 4.5 on August 5, 1972. Journal of Geophysical Research 88:161-173 (1983).

After the unusually strong compression of the earth's magnetosphere associated with the August 1972 geomagnetic storm, large amplitude ULF pulsations were observed for several hours in space by Explorer 45

magnetic field and particle instruments near L = 4.5 and at magnetic observatories on the ground over a large range of latitudes. Spectral analysis of Explorer 45 magnetometer data suggests that a compressional mode oscillation coupled to a transverse mode oscillation. Exhancements in amplitude of a 300-s-period wave near 0040 UT August 5 coincide with an intensification of 100- to 1000-Hz magnetic and electric field oscillations and with the appearance of enhancements of fluxes of energetic ions. During this period the ion pitch angle distribution in each available energy channel (24-300 keV) followed a periodic sequence, apparently synchronized with the magnetic pulsations, from normal trapping (highest fluxes near 90° and lowest near 0° and 180°) to a nearly isotropic particle distribution. During the transitions the particle flux near 90° pitch angle was alternately larger earthward of the satellite (before isotropy) and larger radially outward from the satellite (after isotropy). Intense field-aligned fluxes of lower energy ions (E ≤ 5 keV) were observed periodically throughout the interval. Possible configurations of the magnetosphere consistent with the wave and particle observations are discussed, the most likely candidate being the presence of a wavelike boundary near the satellite. It is possible that the satellite sensed the low-latitude boundary layer at L = 4.5 during this period of extreme magnetospheric compression.

SE-021
Flå, Toi, V. A. OSHEROVICH, and A. Skumanich. On the magnetic and thermodynamic consequences of the return-flux sunspot model. The Astrophysical Journal 261:700-709 (1982).

The magnetic structure of sunspots from photosphere to low corona is considered on the basis of a new magnetohydrostatic theory of sunspots. The first numerical solutions of the basic nonlinear force-balance equation which takes into account returning magnetic flux are obtained using observational data for the maximum field, umbral, and penumbral size and for the vertical distribution of pressure on the sunspot axis and in the quiet Sun. Both vertical and horizontal distributions for the magnetic field were obtained as well as its vertical gradient. Further, the pressure and temperature distributions consistent with this field were also obtained. The dependence of the model on the Wilson depression, the maximum magnetic field of the sunspot, and the amount of return magnetic flux is investigated. A "global" force-balance relation is found to hold which relates the magnetic field gradient on the spot axis with the maximum magnetic field and the pressure deficit, or Wilson depression, in the spot photosphere.

SE-022
GISLASON, G. A. Interplanetary disturbances produced by a simulated solar flare and warped heliospheric current sheet. Final NOAA Contract Report. (1982)

A recently developed nonplanar, time-dependent magnetohydrodynamic (MHD) model (Wu et al., 1982) was used to study the interplanetary disturbances produced by a compound event in the heliosphere. That is, a steady-state interplanetary medium is first disturbed by a simulated equatorially-fluctuating current sheet. After a few days (100 hr), the disturbed interplanetary medium is again perturbed by a solar flare-generated shock wave. Attention is directed toward the differences that are caused by the presence of the equatorially-fluctuating (warped) current sheet.

SE-023
Han, S. M. A development of three-dimensional, time-dependent magnetohydrodynamics numerical model. Tennessee Technological University (1983). NOAA Contract Report.

A three-dimensional, time-dependent magnetohydrodynamics (MHD) numerical code based on the Lax-Wendroff finite difference method is developed. The present numerical codes consist of two separate programs; one for the three-dimensional, steady-state modeling and the other for the modeling of transient MHD wave propagations through initially 3-D steady-state medium.
A representative 3-D steady-state solar wind condition between 18 solar radii and 1.1 AU are generated by using the 3-D, steady-state code. Time-dependent, 3-dimensional responses of solar wind to a shock wave perturbation at 18 solar radii are simulated by using the unsteady-state 3-D code. Numerical results are qualitatively in good agreement with physical expectations.

SE-024
Heath, D, F., DONNELLY, R. F., MERRILL, R. Gregg. NIMBUS-7 SBUV Observations of Solar UV Spectral Irradiance Variations Caused by Solar Rotation and Active-Region Evolution. NOAA Tech. Rept. ERL 424, ARL 7 (PB83- N/A). 48 pp. (1983).

Observations of temporal variations of the solar UV spectral irradiance over several days to a few weeks in the 160-400 nm wavelength range are presented in detail. The measurements were made by the Solar Backscatter Ultraviolet experiment on the NIMBUS-7 satellite during the period November 7, 1978, to

October 26, 1979. The spectra of the variations in solar UV radiation caused by active-region evolution and solar rotation are presented for the 15 largest variations. To a first-order approximation, these 15 cases have essentially the same spectral shape and a small range in itensity. At wavelengths shorter than about 208 nm, the aluminum continuum enhancement dominates the spectra; at longer wavelengths, the magnesium continuum and lines dominate. The average spectrums for the 15 cases is interpreted as being the spectrum for variations caused by solar rotation. Second-order effects, probably caused by active-region evolution, are discussed. Autocorrelation analysis of the data indicates a peak at periods or lags of about 27 days where the peak may broaden toward lags of about 25 days at wavelengths longer than the aluminum edge, i.e., in the 208-300 nm range.

SE-025

KAMIDE, Y. The two-component auroral electrojet. Geophysical Research Letters 9:1175-1178 (1982).

By using the AL index for one year as well as some of the IMS meridian chain records, the longitudinal center of the substorm westward electrojet is examined. Although on the average AL is most often dominated by stations located near 0300 MLT, the westward electrojet during the expansion and maximum phase of substorms tends to be centered in the premidnight to early morning sector, and, during the recovery phase, it is most intense in morning hours. It is suggested that the substorm-associated westward electrojet consists of two components which have different characteristic times; one produced mainly by Hall conductivity enhancements which dominate in the midnight sector and the other one by soutward electric fields in the morning sector.

SE-026

KAMIDE, Y. Comment on 'an evaluation of three predictors of geomagnetic activity' by R. E. Holzer and J. A. Slavin. Journal of Geophysical Research 88:4953-4954 (1983).

In the recent paper of particular interest here, Holzer and Slavin [1982] have reported the results of an assessment of three 'solar wind-magnetosphere' coupling functions for their ability serving the best predictors of auroral-zone magnetic activity. Employing a priori selection criteria and averaging processes for solar wind data and the AL index, a regression analysis has been made. To this end, correlation coefficients between AL and each of the three functions are typically more than 0.8, sometimes reaching 0.99 depending upon subgroups within their data set. The main purpose of this comment is to point out that such high correlations appear to result primarily from their analysis techniques and data selection criteria, making it difficult to determine the relative importance of the physical parameters under consideration. This comment shall discuss further that in view of the increasingly wide use of similar statistical techniques in seeking substorm mechanisms, it might be quite meaningful to list scientific topics that can or cannot be addressed by using the obtained results. It may not necessarily be inappropriate to state that the present comment is directed not only to Holzer and Slavin [1982] but also to some other recent correlation work on similar subjects.

SE-027

KAMIDE, Y., B.-H. Ahn, S.-I. Akasofu, W. Baumjohann, E. Friis-Christensen, H. W. Kroehl, H. Maurer, A. D. RICHMOND, G. Rostoker, R. W. Spiro, J. K. Walker, and A. N. Zaitsev. Global distribution of ionospheric and field-aligned currents during substorms as determined from six IMS meridian chains of magnetometers: initial results. Journal of Geophysical Research 87:8228-8240 (1982).

As a part of the joint efforts of operating six meridian chains of magnetometers during the IMS, magnetic records from 70 stations are used to deduce patterns of electric fields and currents in high latitudes on March 17, 18, and 19, 1978. First of all this data set is used to examine the fidelity of the AE(12) index by comparing it with the AE(70) index and also the fidelity of the AL(70) index as a measure of the total westward electrojet intensity. The coefficients for the two correlations are found to be more than 0.8. Then the distribution of both ionospheric currents and field-aligned currents, as well as the elecric field, are for the first time determined with a time resolution of 5 min by using an appropriate conductivity distribution model. Although much improvement is still needed for better accuracy, especially in the estimation of ionospheric conductivity, it has now become possible to study the growth and decay of the three-dimensional current system over the north polar region during individual magnetospheric substorms with sufficient time resolution. Our initial results show that the gross features of the instantaneous distributions of the ionospheric and field-aligned currents are remarkably similar to the daily average pattern during a very weak activity and at different substorm epochs and that the large-scale current pattern grows and decays systematically as a whole. There are, however, significant changes in local scales.

SE-028
   KAMIDE, Y., and S.-I. Akasofu. Notes on the auroral electrojet indices. <u>Reviews</u> <u>of</u> <u>Geophysics</u> <u>and</u>
   <u>Space</u> <u>Physics</u> 21:1647-1656 (1983).

   The auroral electrojet indices (AU, AL, and AE) have served well for more than two decades as measures
of magnetospheric substorm activity. However, as substorm studies have progressed considerably during the
last several years, the accuracy of the present electrojet indices has become an important issue. Thus it
is opportune to reexamine and evaluate the accuracy of the present electrojet indices and improve them if
necessary. For a better use of the present indices and for future improvement we examine the limitations
of the auroral electrojet indices as an accurate quantitative measure of the auroral electrojets and of
magnetospheric substorms. Such limitations should be kept in mind in studying individual substorms, the
correlation with solar wind parameters, etc., particularly because the accuracy of the AE index decreases
for AE < ∿250 nT. Some of the limitations arise from the data availability and also from the present
simplified scheme in deriving them, but some of them originate in the definition itself. A few sugges-
tions are made to improve the present indices, which can be implemented efficiently when digital outputs
become available from all the observatories contributing to the electrojet indices.

SE-029
   KAMIDE, Y., H. W. Kroehl, A. D. RICHMOND, B.-H. Ahn, S.-I. Akasofu, W. Baumjohann, E. Friis-Christensen,
   S. Matsushita, H. Maurer, G. Rostoker, R. W. Spiro, J. K. Walker, and A. N. Zaitzev. Changes in the
   global electric fields and currents for March 17-19, 1978, from six IMS meridian chains of
   magnetometers. <u>World</u> <u>Data</u> <u>Center</u> <u>A</u> <u>for</u> <u>Solar-Terrestrial</u> <u>Physics,</u> <u>Report</u> <u>UAG-87</u> , NOAA, Environmental
   Data and Information Service, Boulder, CO 80303 (1982).

   No abstract.

SE-030
   KAMIDE, Y., and A. D. RICHMOND. Ionospheric conductivity dependence of electric fields and currents
   estimated from ground magnetic observations. <u>Journal</u> <u>of</u> <u>Geophysical</u> <u>Research</u> 87:8331-8337 (1982).

   Recent efforts in estimating the global distribution of the electric potential as well as of ionospheric
and field-aligned currents on the basis of ground magnetic records are reevaluated. For this purpose, we
have repeated crucial tests for the algorithms by using a data base from the IMS Alaska chain of magnetic
observatories along with completely different ionospheric conductivity models. It is found that the
ionospheric current patterns are only weakly dependent on the choice of the conductivity, while the calcu-
lated field-aligned currents are somewhat more sensitive and the electric field is quite sensitive to the
assumed conductivity, as expected. A test is also conducted by using the calculated field-aligned
currents as inputs to an inverse calculation to attempt to reproduce the original ground magnetic pertur-
bations. The results were quite satisfactory, indicating that the numerical accuracy of the algorithms is
adequate. These tests increase our confidence that ground magnetic records from a close network can be
used to study the extent to which the magnetosphere and ionosphere are electrically coupled.

SE-031
   KAMIDE, Y., and J. F. Vickrey. Variability of the harang discontinuity as observed by the Chatanika
   radar and the IMS Alaska magnetometer chain. <u>Geophysical</u> <u>Research</u> <u>Letters</u> 10(2):159-162 (1983).

   The relative location of ionospheric parameters and ground magnetic perturbations in the vicinity of the
Harang discontinuity is examined. For this purpose, we use combined observations of the Chatanika inco-
herent scatter radar and the IMS Alaska meridian chain of magnetometers, which were continuously measuring
the crucial ionospheric parameters near the Harang discontinuity when a sizeable substorm took place. The
Harang discontinuity, as defined by the reversal of the north-south electric field, is found to be located
at 1-2° poleward of the discontinuity identified by the conventional method of using ground magnetic per-
turbations. It is also found that the relative location of auroral conductivity enhancements is quite
variable, depending perhaps upon substorm time. During relatively quiet times and the early stage of a
substorm, a conductivity enhancement occurs only on the poleward side of the Harang discontinuity defined
by the electric field reversal, whereas the enhancement surges equatorward extending beyond the discon-
tinuity during the maximum to recovery phase of a substorm.

SE-032
   KIKUCHI, T. Distribution of energy input due to auroral protons and electrons. <u>Journal</u> <u>of</u> <u>the</u> <u>Radio</u>
   <u>Research</u> <u>Laboratories</u> 30;129:15-33 (1983).

Local time and latitudinal characteristics of auroral proton and electron (E = 300 - 20000 eV) precipitation are studied by making use of total energy input data detected by the polar-orbiting TIROS-N and NOAA-6 satellites on a moderately disturbed (Kp = 4 - 5) day, November 13, 1979. The energy input due to auroral particles occurs in a circular belt of geomagnetic latitudes between 55° and 75°. The energy flux on the night side is more than one order of magnitude greater than on the dayside. Electrons play a major role in the energy deposit in the auroral atmosphere. However, the energy flux of protons is sometimes comparable to that of electrons on the dayside. Moreover, protons are a major component around the noon (1100 - 1300 MLT). It is suggested that protons on the dayside originate in the ring current surrounding the earth, while both protons and electrons are diffused from the near earth plasma-sheet into the overall nightside and partly the dayside auroral atmosphere. Three kinds of latitudinal structures of proton and electron precipitation are observed in the auroral zone except for the pure proton precipitation in the noon sector. The equatorward portion of the auroral precipitation region consists of only protons in the evening and afternoon sectors, whereas only electrons in the midnight and early morning sectors. These two distinct features are separated at 1900 MLT meridian. This indicates that injection of protons and electrons took place on the evening meridian. Another feature in the evening sector is that intensified electron precipitation accompanies decreased protons. These electrons may be inverted-V electrons. It is found in the late morning sector that pure proton precipitation takes place exclusively poleward of an electron precipitation region. This suggests that protons are accelerated by field-aligned electric fields in a narrow isolated region poleward of late morning auroral zone.

SE-033
Kikuchi, T., and D. S. EVANS. Quantitative study of substorm-associated VLF phase anomalies and precipitating energetic electrons on November 13, 1979. Journal of Geophysical Research 88:871-880 (1983).

The phase anomalies associated with substorms are observed on VLF signals propagating on transauroral paths (transmitters at OMEGA-ALDRA (13.6 kHz), GBR (16.0 kHz), and OMEGA-NORTH DAKOTA (13.6 kHz)) which were continually received at Inubo, Japan, during the events on November 13, 1979. Detailed comparisons are made between these phase anomalies and geomagnetic bays, and quantitative relations are obtained with precipitating energetic electrons (E > 30. E > 100, and E > 300 keV) detected on board the TIROS-N and NOAA 6 satellites. It is concluded that two types of VLF phase anomalies exist which, in turn, are associated with two phases in the history of energetic electron precipitation into the atmosphere. The first type of phase anomaly is associated with direct injection of energetic electrons into the outer magnetosphere and and atmosphere which, in turn, is completely correlated in time with development of the auroral electrojet current system. The second type arises from energetic electrons which subsequently precipitate from a trapped electron population and has a delayed onset and prolonged duration. An excellent quantitative correlation is obtained between the logarithm of the electron flux and the magnitude of the phase anomaly on the OMEGA-ALDRA signal. From the local time characteristics of this quantitative relation it is deduced that the electrons with E > 300 keV are the main source of D region ionization responsible for the VLF phase anomaly.

SE-034
LYONS, L. R. Causes of particle precipitation along auroral field lines. In High-Latitude Space Plasma Physics, B. Hultqvist and T. Hagfors (ed.), Plenum Publishing Corp., 493-513 (1983).

Quantitative theoretical results have been obtained for three basic causes of auroral particle precipitation. Pitch angle diffusion of trapped plasma sheet particles driven by resonant wave-particle interactions leads to isotropic pitch angle distributions at lower energies, with a transition to increasingly anisotropic distributions at higher energies. Diffuse auroral electron precipitation (including that associated with pulsating aurora) can be explained by such interactions. Energization of ions in the current sheet via single particle motion leads to isotropic auroral precipitation at all energies from $\sim$1 keV to nearly 1 MeV. Much of observed auroral ion precipitation is consistent with that expected from this current sheet energization. The electrons responsible for discrete auroral are accelerated by a field aligned potential difference $V_\parallel \gtrsim 1$ keV. The overall electrodynamics of this energization, and the associated currents and electrical potential variations along auroral field lines and within the ionosphere, can be explained by single-particle motion along the field lines and current continuity in the ionosphere. The structure of the potential distribution at high-altitudes responsible for the discrete aurora has been identified but not explained.

SE-035
Madden, R. P. Project for improved performance of radiometric standard detectors (110-360nm). National Bureau of Standards, Washington, D.C. 20234. Final NOAA Contract Report (1983).

The research and development work to improve the performance of radiometric standard detectors in the ultraviolet wavelength range 110-360 nm is reported. Three items were identified as needing improvement,

namely: (1) the durability of the vacuum seal between the magnesium fluoride window to the glass photo-diode envelope, (2) the location of the photocathode, and (3) the photoelectron collection efficiency. An indium alloy was used to improve the window. An opaque photocathode was located at the inside rear of the photodiode assembly away from the window surface. The improved electron collection efficiency permits lower operating voltages. The main disadvantage of the new design is the higher production costs relative to existing detectors.

SE-036
  Maxwell, A., and M. DRYER. Measurements on a shock wave generated by a solar flare. Nature 300:237 (1982).

Shock waves generated by intense solar flares may be driven by a large amount of ejected mass, about 5×10^{16}g, and the total energy involved may be of the order of 10^{32}erg. The shocks may have initial velocities of the order of 2,000 km s^{-1} and, in their exodus through the corona, may be accompanied by fast-moving optical transients, the emission of highly characteristic radio signatures and the acceleration of particles to quasi-relativistic velocities. Here we review data on a high-velocity shock generated by a flare on 18 August 1979, 1400 UT, comment on some previously deduced velocities for the shock, and then present a model, based on current computer programs to account for the overall characteristics of the shock as it propagated through the corona and the interplanetary program.

SE-037
  Mullan, D. J., and R. S. Steinolfson. Closed and open magnetic fields in stellar winds. The Astrophysical Journal 266:823-830 (1983). NOAA Contract Report.

We report on a numerical study of the interaction between a thermal wind and a global dipole field in the Sun and in a giant star. In order for closed field lines to persist near the equator (where a helmet-streamer-like configuration appears), the coronal temperature must be less than a critical value T_e, which scales as M/R. This condition is found to be equivalent to the following: for a static helmet streamer to persist, the sonic point above the helmust must not approach closer to the star than 2.2-2.6 stellar radii. Implications for rapid mass loss and X-ray emission from cool giants are pointed out. Our results strengthen the case for identifying empirical dividing lines in the H-R diagram with a magnetic topology transition locus (MTTL). Support for the MTTL concept is also provided by considerations of the breakdown of magnetostatic equilibrium.

SE-038
  Nakai, H., and Y. KAMIDE. Response of nightside auroral-oval boundaries to the interplanetary magnetic field. Journal of Geophysical Research 88:4005-4014 (1983).

The poleward and equatorward boundaries of the nightside auroral oval are scaled from DMSP auroral imagery and their response to the interplanetary magnetic field (IMF) is investigated. Although, as expected, the B_z component of the IMF is found to be the dominant factor in determining the latitude of the oval equatorward boundary, the correlation coefficients are not very high: the large variance results from the considerable scatter of points when the IMF is northward and large. By examining the oval boundaries from successive orbits, it is suggested that most of the expanded oval cases during such northward IMF periods occurred within several hours after periods of southward IMF. This indicates that the response of the oval to northward turnings (i.e., the contraction of the oval) takes place rather slowly, so that the contracted oval in its smallest size can be established only when the IMF has a northward component steadily for more than several hours. The observed oval equatorward boundary is mapped onto the equatorward plane of the magnetotail, and then plasma sheet processes are discussed with respect to present theories on the formation of the Alfvén layer as a result of the penetration of solar wind electric fields into the magnetotail.

SE-039
  Nishida, A., Y. KAMIDE. Magnetospheric processes preceding the onset of an isolated substorm: A case study of the March 31, 1978, substorm. Journal of Geophysical Research 88:7005-7014 (1983).

We examined in detail the effect of a southward turning of the interplanetary magnetic field (IMF) on the state of the magnetosphere, taking advantage of the availability of the data from IMS magnetometer meridian chains and from several spacecraft. A clear onset substorm occurred on March 31, 1978, when the magnetometer stations were located in the midnight to morning sector and the spacecraft were near the equatorial plane of the nightside magnetosphere. The onset time of the substorm expansion phase could be determined unambiguously in terms of both ground-based magnetic and auroral signatures, and there was an interval lasting about 1 hour between the IMF southward turning and this onset. In this intervening

interval the ionospheric current system of the DP 2 type developed. This enhancement of the ionospheric current was driven directly by the solar wind-magnetosphere coupling. The onset of the expansion phase was then associated with the decrease in the magnetic field energy density in the tail, providing evidence that the substorm energy was supplied by the release (unloading) of energy from the tail. It is most likely that substorm energy dissipated in the auroral ionosphere throughout this relatively isolated and simple event was supplied by two components, 'directly driven' and 'loading-unloading', the relative importance of which varied depending on the different substorm phases.

SE-040
  OSHEROVICH, V. A. The study of toroidal magnetic configurations in a spherically symmetric gravitational field with applications to coronal loops and transients. Astrophysics and Space Science 86:453-469 (1982).

Our procedure for solving MHD equations is to search for a solution in an area that is restricted by boundary surfaces. This procedure requires the magnetic field to be truncated on the boundary. As a result, boundary current sheets appear. This approach is certainly acceptable for laboratory plasma experiments in which these surfaces are made of metal. For astrophysically relevant plasma, an alternative approach has been formulated by the author. We require the total magnetic energy, W, to be finite and, simultaneously, the magnetic field B to be continuous. The proposed approach leads to an eigenvalue problem that is treated analytically. The complete set of exact MHD solutions with multi-toroidal structure is obtained. These solutions are applied to coronal loops and transients, using the similarity assumption for time-dependent solutions.
  The derived pressure and density excess distributions are discussed. The estimation of the total mass excess, as well as the minimum value of the magnetic field intensity, is demonstrated. An indirect way of obtaining magnetic field measurements for transients, based on the developed model, is proposed.

SE-041
  OSHEROVICH, V. A. The magnetohydrostatic atmosphere around a gravitating body. The Astrophysical Journal 261:370-374 (1982).

The axisymmetric magnetic structure around the gravitating body is considered. Using the similarity assumption, the author reduced the problem from a nonlinear elliptic partial differential equation to an ordinary nonlinear differential equation. The particular solution with a topology including a nondipole field structure is discussed. Gas pressure, density, and temperature, corresponding to this magnetic atmosphere, are obtained.

SE-042
  OSHEROVICH, V. Compressible, conductive, steady MHD flow in a gravitational field. Astrophysics and Space Science 93:221-228 (1983).

The magnetohydrodynamics of a compressible fluid with finite electrical conductivity in a gravitational field is treated analytically. For the case of one ignorable coordinate in cylindrical and Cartesian coordinates the problem is reduced to a scalar partial differential equation. The ideal gas equation of state is considered. For simplicity, the new equation is derived for a two-component motion. The application of this result to mass flow in sunspots is discussed.

SE-043
  OSHEROVICH, V. A self-similar magnetohydrostatic model of a quiescent prominence. The Astrophysical Journal 271:847-852 (1983).

A self-similar magnetohydrostatic model of a quiescent prominence is proposed. The basic ordinary differential equation of the new theory is derived, along with pressure, temperature, and density distributions.

SE-044
  OSHEROVICH, V. A., T. Flå, and G. A. Chapman. Magnetohydrostatic model of solar faculae. The Astrophysical Journal 268:412-419 (1983).

A self-similar magnetohydrostatic model of solar faculae is presented. The model is based on the Schlüter-Temesvary equation, originally derived for sunspots. Magnetic tension and twisted magnetic field are taken into account. The exact magnetohydrostatic solution obtained from an observationally derived pressure deficit basically confirms Chapman's semiempirical facular model without tension.

The difference between a facula and a sunspot and the thermodynamic consequences of a twisted magnetic field are discussed.

SE-045

PUGA, L. C., and R. F. DONNELLY. Studies of solar Ca K plages and UV, X-ray and 10 cm variations. NOAA-TM-ERL-SEL-65 (PB83-186163), 44 pp. (1982).

The literature about Ca K plages is briefly reviewed with particular emphasis on the statistics of plage lifetimes, areas, and intensities. Inconsistencies among reports of Ca K plage data were examined and occasional problems found. Plage area is shown to be correlated to the associated sunspot area but the relation includes appreciable scatter. Estimates of the solar 1-8A X-ray flux based on Ca K plage data are shown to be more accurate than those based on the 10.7 cm radio flux. Daily means of the solar soft X-ray flux observed primarily from the SMS-2 satellites are presented for 1975-1976. The quality factor for solar soft X-ray data are presented for 1975-1980.

SE-046

Rich, F. J., and Y. KAMIDE. Convection electric fields and ionospheric currents derived from model field-aligned currents at high latitudes. Journal of Geophysical Research 88:271-281 (1983).

Computer simulations of convection electric fields and ionospheric currents derived by high-latitude field-aligned currents (FAC) have been conducted with an emphasis on field-aligned currents in the dayside high-latitude region. The particle-induced conductivity is based upon average particle precipitation fluxes observed by Atmospheric Explorer. In order to examine conclusions drawn from satellite observations, the field-aligned currents in the region of the dayside cusp are modeled in two ways. First, the cusp FAC are given as distinct currents poleward of the auroral oval field-aligned currents. Their location and direction of current are determined by the B_y component of the interplanetary magnetic field. Second, the cusp FAC are given as an extension of the morning (or evening) region 1 current across the noon meridian and into the polar region for IMF B_y <0 (or B_y >0). The second, or overlapping, representation of FAC sheets near noon yields ionospheric currents that match DPY current system better than the distinct cusp FAC model. The calculated convection electric fields do not show a drawing together of electric field equipotentials near noon to form a 'throat' of rapid convection. Variations of the model might yield a throatlike convection pattern on one side of noon but not both sides. The model results give a westward electrojet on the poleward edge of the evening region 1 as a natural part of the global ionospheric current system.

SE-047

RICHMOND, A. D. Ionospheric electrodynamics and irregularities: a review of contributions by U.S. scientists from 1979 to 1982. Reviews of Geophysics and Space Physics, 21(2):234-241 (1983). U.S. National Report to International Union of Geodesy and Geophysics 1979-1982.

The past four years have seen important advances in our understanding of global ionospheric electrodynamics and of ionospheric irregularities. The accumulation of ionization drift measurements by radar and satellite have led to the development of quantitative global electric field models. Extensive ground- and satellite-based magnetic field measurements have given improved information about electric currents. Quantitative models of high-latitude ionospheric electrical conductivities have been produced. Theoretical modeling efforts have given us the capability of inferring unknown electrodynamic parameters from measured quantities on a global basis, and allow us to assess quantitatively the influence of ionospheric electric fields and currents on the ionospheric plasma and on the neutral atmosphere. Ionospheric irregularities have also been extensively studied by both experimental and theoretical means in recent years, but are treated only very briefly in this report, with the reader referred to more comprehensive review articles for further information.

SE-048

Rush, C. M., M. PoKempner, D. N. ANDERSON, F. G. Stewart, and J. Perry. Improving ionospheric maps using theoretically derived values of f_oF_2. Radio Science 18:95-107 (1983).

The results of a study to improve the global maps of monthly median values of the F_2 region critical frequency, f_oF_2, using values determined from a theoretical model are presented. Values of the mid-latitude F_2 region critical frequency that could be used to improve the prediction of f_oF_2 in regions of the earth inaccessible to ground-based measurements were obtained. This was accomplished by including in the theoretical calculations realistic physical processes along with a realistic geomagnetic field model. Parameters were adjusted so that agreement was achieved between calculated and observed f_oF_2 values as a

function of local time at different stations, and then these same input parameters (i.e., neutral wind field, and neutral atmospheric model) were assumed valid at all regions of interest where the major differences in the geomagnetic field line configuration. Coefficients that yield global representations of f_oF_2 were then determined using the theoretically derived f_oF_2 values, and the predicted critical frequencies were compared with observed values to estimate the degree of improvement.

SE-049
Sanahuja, B., V. Domingo, K.-P. Wenzel, J. A. JOSELYN, and E. Keppler. A large proton event associated with solar filament activity. Solar Physics 84:321-337 (1983).

We report observations made from several interplanetary spacecraft, of the large low-energy particle event of 23-27 April, 1979 associated with solar filament activity. We discuss the intensity, spectral and directional evolution of the event as observed in the energy range 35-1600 keV on ISEE-3, located $\sim$0.99 AU from the Sun upstream of the Earth. We demonstrate that the shock disturbance propagating through the interplanetary medium and observed at ISEE-3 on 24/25 April strongly controls the particle event. From a comparison of the ISEE-3 observations with those on other spacecraft, in particular on Helios-2, located at 0.41 AU heliocentric distance near the Sun-Earth line, we identify the solar filament erupting on late 22 April near central meridian as the trigger for the propagating shock disturbance.
This disturbance which comprises a forward shock and a reverse shock at the orbit of ISEE-3 is found to be the main source of the energetic proton population observed.

SE-050
Schmahl, E. J., M. R. Kundu, K. T. Strong, R. D. Bentley, J. B. SMITH, JR., and K. R. Krall. Active region magnetic fields inferred from simultaneous VLA microwave maps, X-ray spectroheliograms and magnetograms. Solar Physics 80:233-249 (1982).

A series of VLA maps at 6 cm wavelength have been generated from observations of a solar active region (NOAA 2363) on 29 and 30 March, 1980. During the same period, X-ray spectroheliograms were acquired for this region in the lines of OVII, NeIX, MgXI, SiXIII, SXV, and FeXXV, with X-ray Polychromator (XZRP) aboard the Solar Maximum Mission (SMM). Intervals of relative quiescence (i.e., when X-ray flares and centimeter wave bursts were not evident) were selected for microwave mapping. The resulting VLA maps have spatial resolution of 4" x 4", and generally show two or more sources whose slowly evolving substructures have spatial scales of 10"-30". These maps were co-registered with H_α photographs (courtesy of AF/AWS SOON, Holloman and Ramey AFB) to an accuracy of +8". Similarly, the X-ray spectroheliograms have been co-registered with white light photographs to about the same accuracy. Magnetograms from KPNO and MSFC have also been co-aligned, and the magnetic X-ray, and microwave features compared. In general we have found that (a) the peaks of X-ray and 6 cm emission do not coincide, although (b) the sources in the two wavelength domains tend to overlap. These facts in themselves are evidence for the existence of opacity mechanisms other than thermal bremsstrahlung. In order to quantify this assertion, we have computed differential emission measures to derive densities and temperatures. Using these and calculated force-free magnetic fields from Kitt Peak magnetograms, we present an assessment of the mechanism of gyroresonance absorption at low harmonics of the electron gyrofrequency as the source of opacity responsible for the microwave features. We conclude that large-scale currents must be present in the active region loops to account for the bright 6 cm sources far from sunspots.

SE-051
SPJELDVIK, W. N. Ionic composition of the earth's radiation belts. Journal of Geophysics 52:215-238 (1983).

Several different ion species have been positively identified in the earth's radiation belts. Besides protons, thre are substantial fluxes of helium, carbon and oxygen ions, and there are measurable quantities of even heavier ions. European, American and Soviet space experimenters have reported ion composition measurements over wide ranges of energies: at tens of keV (ring-current energies) and below, and at hundreds of keV and above. There is still a gap in the energy coverage from several tens to several hundreds of keV where little observational data are available. In this review emphasis is placed on the radiation belt ionic structure 100 keV. Both quiet time conditions and geomagnetic storm periods are considered, and comparison of the available space observations is made with theoretical analysis of geomagnetically trapped ion spatial, energy and charge state distributions.

SE-052
SPJELDVIK, W. N., T. A. FRITZ. Experimental determination of geomagnetically trapped energetic heavy ion fluxes. In Energetic Ion Composition in the Earth's Magnetosphere, R. G. Johnson (ed.) Terra Scientific Publishing Company, Tokyo, 369-421 (1983).

The observed spatial, directional and spectral characteristics of geomagnetically trapped heavy ions are reviewed. It is found that ions heavier than protons are significantly abundant in the earth's radiation belts, not only at low (ring-current) energies, but also at multi-MeV energies. Observations both at the geomagnetic equator and at low altitudes on the corresponding L-shell show the important roles played by the heavy ions. the heavy ion-to-proton flux ratio can exceed unity when compared at equal total ion energy. This is particularly the case at several MeV energies and in the outer radiation zone. In contrast, comparisons at equal energy per nucleon generally favor protons. The trapped fluxes of helium ions, of carbon, nitrogen and oxygen (CNO) ions, and of ions heavier than fluorine all exhibit high degrees of pitch angle anisotropy. Many of the observed radiation belt particle distribution characteristics are in agreement with first-order (quiet time) theoretical predictions, although some of the finer details await further research.

SE-053
Steinolfson, R. S. Dynamic modeling of coronal transients and interplanetary disturbances. University of Alabama, Huntsville, AL. Final NOAA Contract Report (1982).

No abstract.

SE-054
Steinolfson, R. S. Coronal loop transients in streamer configurations. Astronomy and Astrophysics 115:39-49 (1982). NOAA Contract Report.

No abstract.

SE-055
SUESS, S. T. Operational uses for a solar soft x-ray imaging telescope. NOAA-TM-ERL-SEL-66 (PB83- N/A), 45 pp. (1983).

Taken from space, above the earth's atmosphere, x-ray images of the sun reveal the structure of the corona and magnetic loops, flares and erupting filaments against a black solar disk. This information can be put to immediate use to improve present space environment monitoring and forecasting, and to provide entirely new products and services. An operational use exists, and details of this use are described here. Furthermore, the instruments necessary to make x-ray photographs have been flown on rockets and spacecraft many times so that no new technological development would be required to realize the benefits to the Space Environment Services Center.

SE-056
Tan, A., and S. T. Wu. Model of mid- and low-latitude F region ionosphere and protonsphere. Geofisica Internacional 20(1):11-39 (1981).

The coupled continuity and momentum equations of O^+ ahd H^+ ions in the F region and the protonosphere are solved for a mid-latitude station (arecibo) and a low-latitude station (Jicamarca) to investigate the diurnal behavior of the peak electron density N_mF2, the height of the peak H_mF2, the O^+-H^+ transition height H_{tr} and the tranistion level ion density N_{tr}. The effects of the neutral wind on the N_mF2, H_mF2, N_{tr} and H_{tr} curves above Arecibo are more important than and generally in the opposite direction of those of a sinusoidal electromagnetic drift. The electromagnetic drift plays a far-reaching role in shaping the ionospheric and protonospheric profiles at Jicamarca. An upward drift that peaks during the day produced a 'valley' in the N_mF2 curve, while an upward drift that stays constant during most of the day produces a 'plateau'. The nighttime decay in N_mF2 is due to the combined effects of a slow downward drift and chemical recombination. A nocturnal increase in N_mF2 is due to a sufficiently large downward drift when the resultant 'squeezing' of the field tubes overcomes the O^+ loss rate. The diurnal variations of H_mF2 and H_{tr} tend to follow that of the upward drift velocity pattern, with gradients somewhat smoothed. A downward reversal of the drift at sunset causes an enhancement in the post-sunset N_{tr}.
Finally, the applicability of the model to the study of the total electron content measurements of the ATS-6 radio beacon experiments at Ootacamund is demonstrated. By comparing with the observed values, the probable drift velocities over Ootacamund are determined for October and December, 1975. The drift velocity patterns show broad similarities with those observed over Jicamarca.

SE-057
  Wagner, W. J., R. M. E. Illing, C. B. Sawyer, L. L. House, N. R.Sheeley, Jr., R. A. Howard, M. J.
  Koomen, D. J. Michels, R. N. Smartt, M. DRYER. A white-light/Fe X/Hα coronal transient observation to
  10 solar radii. Solar Physics 83:153-166 (1983).

  Multi-telescope observations of the coronal transient of 15-16 April, 1980 provide simultaneous data
  from the Solar Maximum Mission Coronograph/Polarimeter, the Solwind Coronagraph, and the new Emission Line
  Coronagraph of the Sacramento Peak Observatory. An eruptive prominence-associated white light transient
  is forthe first time seen as an unusual wave or brightening in FeXλ6374 (but not in FeXIVλ5303). Several
  interpretations of this fleeting enhancement are offered.
  The prominence shows a slowly increasing acceleration which peaks at the time of the Fe event. The
  white light loop transient surrounding the prominence expands at a well-documented constant speed to 10
  R_0, with an extrapolated start time at zero height coincident with the surface activity.
  This loop transient exemplifies those seen above 1.7 R_0 in that leading the disturbance is a bright N_e-
  enhanced) loop rather than dark. This is consistent with a report of the behavior of another eruptive
  event observed by Fisher and Poland (1981) which began as a density depletion in the lower corona, with a
  bright loop forming at greater altitudes. The top of the bright loop ultimately fades in the outer corona
  while slow radial growth continues in the legs.

SE-058
  Wu, S. T., M. DRYER, S. M. Han. Non-planar MHD model for solar flare-generated disturbances in the
  heliospheric equatorial plane. Solar Physics 84:395-418 (1983).

  An analysis, with a representative (canonical) example of solar-flare-generated equatorial disturbances,
  is presented for the temporal and spatial changes in the solar wind plasma and magnetic field environment
  between the Sun and one astronomical unit (AU). Our objective is to search for first order global con-
  sequences rather than to make a parametric study. The analysis—an extension of earlier planar studies—
  considers all three plasma velocity and magnetic field components (V_r, V , V_0, and B_r, B_0, B) in any
  convenient heliospheric plane of symmetry such as the ecliptic plane, the solar equatorial plane, or the
  heliospheric equatorial plane chosen for its ability (in a tilted coordinate system) to order northern and
  southern hemispheric magnetic topology and latitudinal solar wind flows. Latitudinal velocity and magne-
  tic field gradients in and near the plane of symmetry are considered to provide higher-order corrections
  of a specialized nature and, accordingly, are neglected, as in dissipation, except at shock waves.
  The representative disturbance is examined for the canonical case in which one describes the temporal
  and spatial changes in a homogenous solar wind caused by a solar-flare-generated shock wave. The
  'canonical' solar flare is assumed to produce a shock wave that has a velocity of 1000 km s^{-1} at 0.08 AU.
  We have examined all plasma and field parameters at three radial locations: central meridian and 33° W and
  90° W of the flare's central meridian. A higher shock velocity (3000 km s^{-1}) was also used to demonsrate
  the model's ability to simulate a strongly-kinked interplanetary field.
  Among the global (first-order) results are the following: (i) incorporation of a small meridional magne-
  tic field in the ambient magnetic spiral field has negligible effect on the results: (ii) the magnetic
  field demonstrates strong kinking within the interplanetary shocked flow, even reversed polarity that –
  coupled with low temperature and low density – suggests a viable explanation for observed 'magnetic
  clouds' with accompanying double-streaming of electrons at directions 90° to the heliocentric radius.

SE-059
  Wu, S. T., Y. Nakagawa, S. M. Han, and M. DRYER. Magnetohydrodynamics of atmospheric transients.
  IV. Nonplane two-dimensional analyses of energy conversion and magnetic field evolution.
  The Astrophysical Journal 262:369-376 (1982).

  The evolution of the magnetic field and the manner of conversion of thermal energy into different forms
  in the corona following a solar flare are examined by a nonplane magnetohydrodynamic (MHD) analysis. In
  the analysis all three components of magnetic field and velocity are treated in a physically self-
  consistent manner, with all physical variables as functions of time (t) and two spatial coordinates
  (r, θ). The difference due to the initial magnetic field, either twisted (force-free) or nontwisted
  (potential), is demonstrated. In both cases, of course, the field becomes non-force-free after the energy
  release, i.e., a flare. As in Papers I and II of this series, two initial field topologies (open vs.
  closed) are considered. The results show that the conversion of magnetic energy is faster for the case of
  the initially twisted (force-free) field in comparison with the initially untwisted (potential) field.
  Also, the twisted field produces a complex structure of the density enhancements. Comparison of the asym-
  metric topological evolution of the intially twisted magnetic fields with several white-light coronal
  transients (observed recently during the Solar Maximum Year) suggests that some preflare, magnetic topolo-
  gies above the site of the energy release are nonpotential. This suggestion is based on the asymmetrical,
  somewhat concentric ("tennis racket" shape), electron density enhancements obtained together with the
  twisted magnetic field lines in this study.

127

SE-060
  Wu, S. T., S. Wang, M. DRYER, A. I. Poland, D. G. Sime, C. J. Wolfson, L. E. Orwig, and A. Maxwell.
  Magnetohydrodynamic simulation of the coronal transient associated with the solar limb flare of 1980,
  June 29, 18:21 UT. Solar Physics 85:351-373 (1983).

  Soft X-ray data from the XRP experiment on SMM are used to generate the temperature and density in the
flaring region of the 1980, June 29 (18:21 UT) solar flare. The temporal data ($T_{max} \approx 20 \times 10^6$ K and n_{mass}
$\approx 4 \times 10^{11}$ cm^{-3}), together with an assumed velocity, are used to simulate mass injection as the input
pulse for the MHD model of Wu et al. (1982a, 1983a). The spatial and temporal coronal response is com-
pared with the ground-base, Mark III K-coronameter observatons of the subsequent coronal transient. The
simulation produces a spatially-wide, large amplitude, temporarily-steepened MHD wave for either of the
two 'canonical' magnetic topologies (closed and open), but no shock wave. This result appears to be con-
firmed by the fact that a type II radio event was observed late in the event for only a few minutes,
thereby indicating that a steepening wave with temporary, marginal shock formation, was indeed present.
The density enhancements produced by the simulation move away from the Sun at the same velocity observed
by the K-coronameter. However, the observation of the coronal transient included a rarefaction that does
not appear in the simulation. A probable explanation for this discrepancy is the likelihood that the
magnitude and temporal profile of the density of the soft X-ray emitting plasma should not have been used
as part of the mass injection pulse. We believe that the temperature profile alone, as suggested by
earlier simulations, might have been a necessary and sufficient condition to produce both the compression
and rarefaction of the ambient corona as indicated by the K-coronameter data. Hence, the dense plasma was
observed by XRP was probably confined, for the most part, close to the Sun during the $\sim$17 min duration of
the observation.

SE-061
  Yau, A. W., B. A. Whalen, A. G. McNamara, P. J. Kellogg, and W. Bernstein. Particle and wave observa-
  tions of low-altitude ionospheric ion acceleration events. Journal of Geophysical Research 88:341-355
  (1983). NOAA Contract Report.

  We report energetic ion and electron, wave, and ambient plasma observations from two sounding rockets
which were launched from Churchill, Canada, into the expansive phases of two auroral substorms and which
passed through source regions of transversely accelerated ionospheric ions (TAI). The two events were
observed at low altitudes (400-600 km) and resulted in ion energization of hundreds of electron volts. In
the acceleration region, the ionospheric ion velocity distribution function in the direction perpendicular
to the local magnetic field ($\perp$B) displayed a distinct, non-Maxwellian, high-energy tail, suggesting ion
cyclotron heating. the plasma density was lower than theoretical quiescent values, by as much as 2 de-
cades in the stronger event. Strong thermal ion drift was observed in the perpendicular ($\perp$B) direction,
but was absent in the parallel ($\parallel$B) direction. Large-amplitude, low-frequency fluctuations in plasma
density were present, and a number of wave modes were observed, including upper hybrid and Langmuir waves,
and whistler, ion acoustic, and ion cyclotron waves. No consistent correlation existed between the
energetic precipitation and the TAI. However, strong field-aligned electron enhancements were observed at
times coincident with the TAI acceleration region. The characteristics of the TAI ion energy spectra were
consistent with a simple model of ion cyclotron acceleration and energy loss due to ion-neutral colli-
sions. These observations are discussed in terms of current theories on electrostatic ion cyclotron acce-
leration and lower hybrid acceleration.

SE-062
  YEH, T. Diamagnetic force on a flux tube. The Astrophysical Journal 264:630-634 (1983).

  A magnetic flux tube immersed in a magnetized medium is subjected to a magnetostatic diamagnetic force.
It results from the inhomogeneity of the ambient magnetic pressure caused by the presence of the extra-
neous conducting body. For a straight flux tube immersed in a uniform external magnetic field, the
diamagnetic force per unit axial length of the flux tube is equal to the vector multiplication of the con-
duction current carried by the flux tube and the external magnetic field produced by external currents. A
nonuniformity of the external magnetic field, which is enhanced by the polarization current induced at the
periphery of the flux tube, will give rise to an additional contribution to the diamagnetic force.
  Mathematically, this is analogous to Kutta-Joukowski's theorem for the aerodynamic lift force on an
aerofoil placed in a streaming fluid. Physically, magnetostatic diamagnetic force is a manifestation of
the Biot-Savart interaction between currents at a distance. It amounts to the force acting on the
currents in the flux tube by the external currents that produce the external magnetic field. In turn, a
diamagnetic force is manifested in the internal stress to exert a nearly uniform force density at the
distributed mass of the flux tube.

SE-063

Cuperman, S., I. Weiss, and M. DRYER. A variational derivation of the velocity distribution functions for nonequilibrium, multispecies, weakly interacting, spherically symmetric many-body systems. _Journal of Statistical Physics_, 32 (2):439 (1983).

No abstract.

SE-064

DONNELLY, R. F. Solar UV spectral irradiance variations. In _Weather and Climate Responses to Solar Variations_. B. M. McCormac (ed.), Colorado Associated University Press, Boulder, 43-55 (1983).

Solar UV radiation and its temporal variations have been recently reviewed by Heath (1980), Hintregger (1981), Simon (1981, 1982), and Donnelly (1982). Simon's reviews have provided quantitative comparisons of UV measurements recorded at different times and grouped according to their general level of activity. Simon pointed out the dilemma that some apparent discrepancies among measurements were roughly comparable to the expected magnitude of long-term UV temporal variations. Heath presented new observations from the NIMBUS-7 satellite of short-term UV variations and also evidence suggesting long-term secular UV variations. Donnelly (1982) discussed the limitations of solar indices for estimating the solar UV flux. The present review emphasizes the recent NIMBUS-7 measurements and first results from the SME satellite. Recent progress in modeling the solar UV flux based on solar spatial inhomogeneities measured by Ca 11 plage data is also emphasized.

SE-065

Springer, B. D. Solar variability and quasi-stationary planetary wave behavior. In _Weather and Climate Response to Solar Variations_. B. M. McCormac (ed.), Colorado Associated University Press, Boulder, 381-394 (1983).

A steady state analysis of winter winds shows that the speed of the upper atmospheric polar vortex approaches and occasionally exceeds the value required to reflect externally forced planetary wave 1 energy back towards the surface of the Earth. Historical observations suggest that solar UV variability and geomagnetic disturbances are two primary forces which modulate the planetary wave trapping mechanism. Through the solar-terrestrial process described, small changes in the Sun's behavior can be physically linked to both short- and long-term changes in tropospheric weather patterns.

WP-001
  Allen, J. S., R. C. Beardsley, W. S. Brown, D. A. Cacchione, R. E. Davis, D. E. Drake, C. Friehe, W. D.
  Grant, A. Huyer, J. D. Irish, M. M. JANOPAUL, A. J. Williams, and C. D. Winart. A preliminary descrip-
  tion of the CODE-1 field program. Woods Hole Oceanog. Inst. Tech. Rept. WHOI-82-51 (1982).

  No abstract.

WP-002
  Altman, W. P., H. M. Gurk, and P. F. Kaskiewicz. Feasibility of a WINDSAT free flyer using an advanced
  TIROS-N satellite. Tech. Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology and Applications,
  Aspen, CO, Aug. 1-4, 1983, TuC3-1 - TuC3-4.

  No abstract.

WP-003
  Bahar, E., and D. E. Barrick. Scattering cross sections for composite surface that cannot be treated as
  perturbed-physical optics problems. Radio Science 18:129-137 (1983).

  Perturbation and physical optics theories have traditionally been used to derive the scattering cross
  sections for composite surfaces that can be regarded as small-scale surface perturbations that ride on
  filtered, large-scale surfaces. In this case, perturbation theory accounts for Bragg scattering, while
  physical optics theory accounts for specular point scattering. However, for a more general class of com-
  posite surfaces that cannot be decomposed in such a manner, the perturbed physical optics approach cannot
  be used. In these cases, it is shown, using the full wave approach, that the specular scattering asso-
  ciated with a filtered surface (consisting of the larger-scale spectral components) is strongly modified
  and that Bragg scattering and specular point scattering begin to blend with each other. Since the full
  wave solution accounts for Bragg scattering as well as specular point scattering in a self-consistent
  manner, it is not necessary to filter (decompose) the composite surface to evaluate the scattering cross
  sections in the general case. However, filtering the composite surface enhances one's physical insight as
  to the validity (or lack thereof) of the perturbed-physical optics decomposition and also facilitates the
  numerical evaluation of the scattering cross sections.

WP-004
  Bahar, E., C. L. RUFENACH, and D. E. Barrick. Scattering cross section modulation for arbitrarily
  oriented composite rough surfaces: Full wave approach. Radio Science 18(5):675-690 (1983).

  As a synthetic aperture radar scans different portions of a rough surface, the direction of the unit
  vector normal to the mean surface of the effective illuminated area (resolution cell) fluctuates. In this
  paper the modulation of the like and cross polarized scattering cross sections of the resolution cell are
  determined as the normal to it tilts in planes that are in and perpendicular to the fixed reference plane
  of incidence. By using the full wave approach, the scattering cross sections are expressed as a weighted
  sum of two cross sections. The first cross section is associated with scales of roughness within the
  effective illuminated area that are large compared to the radar wavelength, and the second cross section
  is associated with small-scale spectral components within the resolution cell. Thus both specular point
  scattering and Bragg scattering are accounted for in a self-consistent manner. The results are compared
  with earlier solutions based on first-order Bragg scattering theory.

WP-005
  BEDARD, A. J., Jr., and C. RAMZY. Surface meteorological observations in severe thunderstorms. Part I:
  Design details of TOTO. J. Appl. Meteorol., 22(5):911-918 (1983).

  The TOTO (Totable Tornado Observatory) device was designed as a prototype meteorological measuring
  instrument for use by severe storm intercept teams. Portions of the instrument evolved from our work in
  producing "hardened" sensors for use in networks for measuring wind shear and severe downslope winds. We
  describe our rationale for choices of measurement parameters, dynamic ranges and measurement resolution.
  TOTO measures the following: wind speed (two ranges) 0-100 mph (44.7 m s^{-1}); 0-250 mph (111.8 m s^{-1}); wind
  direction (0-360°); temperature 0-50°C); static pressure (±20 mb); and corona discharge (±10 µA). We also

describe methods for rapid deployment from the back of a pickup truck. Using ramps and a winch system, the unit can be deployed in less than 15 s. Finally, we discuss plans for testing and possibilities for improving the device.

WP-006
  Byron, S. R., P. E. Cassady, and T. A. Znotins. Chirp analysis for pulsed CO_2 laser oscillators. Tech. Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology and Applications, Aug. 1-4, 1983, Aspen, CO. Optical Society of America, TuD4-1 - TuD4-4 (1983).

  No abstract.

WP-007
  Byron, S. R., S. E. Moody, and T. A. Znotins. Definition study of the WINDSAT laser subsystem. Tech. Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology and Applications, Aug. 1-4, 1983, Aspen, CO. Optical Society of America, TuC4-1 - TuC4-3 (1983).

  No abstract.

WP-008
  CHADWICK, R. B., and E. E. Gossard. Radar remote sensing of the clear atmosphere - review and applications. Proceedings, IEEE, 71(6):738-753 (1983).

  This is a review of clear-air radar with special emphasis on applications. The history of radio scattering from turbulence-induced refractive-index fluctuations is discussed along with current research programs using clear-air radars. Applications involving wind measurement are presently being implemented and the first operational use of clear-air radar will be to improve weather prediction. Eventually, the same clear-air radar system used to observe the weather will be used for optimum routing of aircraft for fuel economy and to estimate transport of pollutants in acid rain studies. Clear-air radar also can potentially be used as an airport hazard monitor for wind shear and wingtip vortices. A new application for clear-air radar is monitoring the presence and height of refractive layers aloft to predict anomalous propagation and estimate unusual radar coverage. Because insects are often detected by clear-air radars, we have included insects as clear-air targets and discuss the use of radar to study insects and birds.

WP-009
  CHADWICK, R. B., J. JORDAN, and T. DETMAN. Radar detection of wingtip vortices. Ninth Conference on Aerospace and Aeronautical Meteorology, June 6-9, 1983, Omaha, Nebraska. American Meteorological Society, Boston, 235-240 (1983).

  No abstract.

WP-010
  CLIFFORD, S. F. Effects of atmospheric refractive turbulence on laser remote sensing. Technical Digest of Topical Meeting on Optical Techniques for Remote Probing of the Atmosphere, 10-12 January 1983, Incline Village, Nevada, Optical Society of America. MA3-1-MA3-4 (1983).

  We review the progress on understanding the effects of refractive turbulence on various lidar configurations. Both reference beam and quasi-coherent lidars are considered.

WP-011
  CLIFFORD, S. F., and R. J. LATAITIS. Turbulence effects on acoustic wave propagation over a smooth surface. Journal Acoustical Society of America 73:1545-1550 (1983).

  A rigorous, mathematical treatment describing refractive turbulence effects on the mean-square pressure p^2 of an isotropic acoustic source radiating above a smooth boundary is presented. The result is energy conserving, is general enough to allow the insertion of an arbitrary refractive-index correlation function, and does not require the ad hoc introduction of arbitrary parameters. This result is compared and contrasted with earlier work by other authors.

WP-012
  DECKER, M. T. A comparison of radiosonde- and radiometrically-derived atmospheric observations.
  Proceedings of the Fifth Symposium on Meteorological Observations and Instrumentation, April 11-15,
  1983, Toronto, Ontario, Canada. American Meteorological Society, 205-206 (1983).

  No abstract.

WP-013
  EARNSHAW, K. B., D. C. HOGG, and R. G. STRAUCH. A triple-beam antenna for wind-profiling radar. NOAA
  TM-ERL-WPL-108 (1982).

  An offset paraboloid with prime-focus feeds that produce three fixed beams, one directed in the zenith,
  and two 15° off zenith (in orthogonal planes) is discussed. The antenna is used for profiling of winds in
  the troposphere at UHF (915 MHz). A unique method involving tilting the reflector produces the desired
  beam directions, and the displacement of the feeds is only $1/\sqrt{2}$ of the conventional displacement. Mea-
  surement of the phase and amplitude of the aperture fields on a 17-GHz scale model show good agreement
  with ray-tracing computation. For the beam offset from boresite in the plane of symmetry, astigmatism is
  the first aberration observed, whereas coma is significant for a beam off-set in the asymmetrical plane.
  Far-field patterns obtained from measurements using a near-field scanner are compared with computation.

WP-014
  EBERHARD, W. L. Eye-safe tracking of oil fog plumes by UV lidar. Applied Optics 22(15):2282-2285
  (1983).

  NOAA's Wave Propagation Laboratory operated a plume-tracking lidar during two field experiments investi-
  gating atmospheric dispersion in complex terrain. The lidar successfully acquired data on oil fog plume
  behavior by detecting the elastic backscatter of the pulsed output of a frequency-doubled ruby laser.
  This UV wavelength (0.3472 µm) met stringent eye safety restrictions. An analysis of signal and noise
  levels demonstrates that plume definition at a wavelength of 0.3472 µm is superior in many cases to that
  at 0.6943 µm when pulse energies are low enough to be eye-safe at the range to the plume. This is often
  true in spite of the high threshold set by the large molecular scatter from the ambient air at the UV
  wavelength. Backscatter coefficients of oil fog at the shorter wavelength were 1-4X larger than at the
  longer wavelength.

WP-015
  Essen, H.-H., M. M. JANOPAUL, E. Mittelstaedt, and J. Backhaus. Surface currents in the German bight
  measured by backscattered radio waves - a comparison with conventional measurements and model results.
  North Sea Dynamics, J. Sundermann and W. Lenz (eds.), Springer-Verlag, New York, 159-165, (1983).

  No abstract.

WP-016
  FORBERG, J. D., and B. L. WEBER. Automatic gain control for an HF Doppler radar receiver. NOAA-TM-ERL-
  WPL-104, (1982).

  No abstract.

WP-017
  GAGE, K. S., J. L. GREEN, B. B. BALSLEY, W. L. ECKLUND, R. G. STRAUCH, and K. J. RUTH. Comparison of
  radar reflectivities between the Sunset and Platteville ST radars. Preprints, 21st Conf. on Radar
  Meteorology, Sept. 19023, 1983, Edmonton, Alta., Canada. American Meteorological Society, 129-134
  (1983).

  No abstract.

WP-018
  Gal-Chen, T., and R. A. KROPFLI. Deduction of thermodynamic properties from dual-Doppler radar aobser-
  vations of the PBL. Preprints, 21st Conf. on Radar Meteorology, Sept. 19-23, 1983, Edmonton, Alta,
  Canada. American Meteorological Society, 33-38 (1983).

No abstract.

WP-019
 Gal-Chen, T., and R. A. KROPFLI. Temperature and pressure perturbations derived from dual Doppler radar
 observations of the PBL and their relationships to turbulence theory. Preprints Ext. Abstr., 6th
 Symposium on Turbulence and Diffusion, March 22-25, 1983 Boston, MA. American Meteorological Society,
 81-84 (1983).

 No abstract.

WP-020
 GAYNOR, J. E. Present and future uses of sodars in air quality studies by industry and government. 7th
 Annual Meeting of the Air Pollution Control Association, June 20-25, 1982, New Orleans, LA, 1-28 (1982).

 No abstract.

WP-021
 GEORGES, T. M. Infrared from thunderstorms. In Thunderstorms: A social, scientific and tech-
 nological documentary, vol. 3, E. Kessler, (ed.), U. S. Govt. Printing Office, Stock No. 003-017-
 00499-6, 117-133 (1983).

 No abstract.

WP-022
 GEORGES, T. M., J. W. Maresca, Jr., J. P. RILEY, and C. T. Carlson. Real-time sea-state surveillance
 with skywave radar. IEEE Journal of Oceanic Engineering OE-8:97-103 (1983).

To extract sea-state information from the ionospherically distorted echoes received by a skywave radar,
we use a signal-processing strategy that permits real-time decisions about the quality of incoming data.
This paper explains the need for an on-line processor and describes some of its engineering details. We
use an array processor to quickly compute all the spectra required to display ocean waveheight, as well as
some indices of data quality, while the radar interrogates an ocean cell. The results are shown in a test
using an experimental radar that mapped waveheight over its North Pacific coverage area. Coverage effi-
ciency was 85 percent, and the radar's waveheight estimates averaged 2 ft (0.6 m) higher than those fore-
cast by a numerical model.

WP-023
 Gossard, E. E. Aircraft hazard assessment from a clear-air radar and meteorological tower study of gra-
 vity wave events. NOAA ERL Special Report, 18 pp. (1983).

An exceptionally well-defined gravity wave event, recorded by radar and on the 300 meter meteorological
tower near Erie, Colorado, is analyzed in this report. Special attention is given the kinematic structure
within the wave to assess possible hazards to aircraft. It is found that changes of about 5 ms^{-1} in ver-
tical velocity would be encountered by an aircraft in a time period of 6.5 s. A similar change in air
speed would be encountered 90° out of phase with the up-downdraft. The maximum effect in this event was
at a height of 100-150 m above the ground. Events of this kind would often occur in fair weather under
thermally stable atmospheric conditions, and would not, therefore, be predicted from the usual reasoning
about near-ground hazards to aircraft.

WP-024
 Gross, A., M. J. POST, R. M. HARDESTY, and F. F. HALL, Jr. Polarization properties of coherent CO_2
 lidar scattering: Target calibration and cloud characteristics. Technical Digest, 2nd Top. Mtg. on
 Coherent Laser Radar: Technology and Applications, August 1-4, 1983, Aspen, CO. Optical Society of
 America TuB2-1 - TuB2-4 (1983).

 No abstract.

WP-025
   HALL, F. F., Jr., R. M. HUFFAKER, R. M. HARDESTY, M. E. Jackson, T. R. LAWRENCE, M. J. POST, R. A.
   RICHTER, and B. F. WEBER. Wind measurement accuracy of the NOAA pulsed, infrared, Doppler lidar.
   Technical Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology and Applications, Aug. 1-4, 1983,
   Aspen, CO. Optical Society of America, WA5-1 - WA5-4, (1983).

   No abstract.

WP-026
   HARDESTY, R. M. Performance of a coherent lidar remote sensor in snow and fog. Proc. Optical
   Engineering for Cold Environments, April 7-8, 1983, Arlington, VA. Int. Soc. of Optical Engineering,
   414:108-113 (1983).

   No abstract.

WP-027
   HARDESTY, R. M. Coherent lidar measurement of range-resolved tropospheric water vapor concentration and
   backscattered signal statistics. Technical Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology
   and Applications, August 1-4, 1983, Aspen, CO. Optical Society of America, ThA4-1 - ThA4-4 (1983).

   No abstract.

WP-028
   HARDESTY, R. M. Atmospheric remote sensing using the NOAA coherent lidar system. In Optical and Laser
   Remote Sensing, D. K. Killinger and A. Mooradian (eds.), Part 8.4, Springer-Verlag New York, 350-355
   (1983) (Also in Proc., Workshop on Optical Laser and Remote Sensing, Feb. 9-11, 1982, Monterey, CA. U.S.
   Army Research Office J3-1 - J3-7).

   No abstract.

WP-029
   HARDESTY, R. M., K. Elmore and M. E. Jackson. Comparisons of lidar and radar wind measurements made
   during the JAWS experiment. Preprints, 21st Conf. on Radar Meteorology, Sept. 19-23, 1983, Edmonton,
   Alta, Canada, American Meteorological Society, 584-589 (1983).

   No abstract.

WP-030
   HARDESTY, R. M., R. W. Lee and D. L. Davis. Real-time processing and display of coherent lidar returns.
   Technical Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology and Applications, August 1-4, 1983,
   Aspen, CO. Optical Society of America, WA2-1 - WA2-4 (1983).

   No abstract.

WP-031
   Hayden, C. M., H. B. Howell, E. R. WESTWATER, G. S. Wade. Results of combining the Profiler and VAS for
   determining temperature and moisture in the atmosphere. Ninth Conf. on Aerospace and Aeronautical
   Meteorology, June 6-9, 1983, Omaha, NE. American Meteorolgical Society, 188-190 (1983).

   No abstract.

WP-032
   HILL, R. J. Inner-scale effect on the irradiance of light propagating in atmospheric turbulence. Laser
   Beam Propagation in the Atmosphere, SPIE Tech. Symp., April 5-6, 1983, Arlington, VA. 410:67-72.

   The definition of the inner scale for atmospheric turbulence is given. Methods of measuring inner scale
   are discussed and typical values are given. Inner-scale effects on irradiance covariance and log-
   amplitude covariance are discussed for both weak and strong scintillation. The covariance width is
   limited by the inner scale for saturated scintillation.

WP-033
  HILL, R. J., and G. R. OCHS. Surface-layer micrometeorology by optical scintillation techniques.
  Technical Digest of Topical Meeting on Optical Techniques for Remote Probing of the Atmosphere, 10-12
  January 1983, Incline Village, Nevada. Optical Society of America, TuC16-1 thru TuC16-4 (1983).

  No abstract.

WP-034
  HOGG, D. C. Propagation effects in an automatic tropospheric profiling system. Third Int. Conf. on
  Antennas and Propagation (ICAP 83), April 12-15, 1983, Norwich, U.K. IEE, 1-3 (1983).

  No abstract.

WP-035
  HOGG, D. C. Antennas employed in an automatic tropospheric profiling system. Third Int. Conf. on
  Antennas and Propagation (ICAP 83), April 12-15, 1983, Norwich, U.K. IEE, 41-43 (1983).

  No abstract.

WP-036
  HOGG, D. C., M. T. DECKER, F. O. GUIRAUD, K. B. EARNSHAW, D. A. MERRITT, K. P. MORAN, W. B. SWEEZY, R.
  G. STRAUCH, E. R. WESTWATER, and C. G. LITTLE. An automatic profiler of the temperature, wind and humi-
  dity in the troposphere. J. Appl. Meteorol., 22(5):807-831 (1983).

  A remote-sensing system for continuously profiling the troposphere is discussed; the prototype Profiler
  utilizes radio wavelengths, thereby achieving essentially all-weather operation. Designed for unattended
  operation, the Profiler employs radiometric and Doppler radar technology. Design, construction and
  calibration of the instruments composing the Profiler system are described along with some of the physics
  and mathematics upon which their operation is based. Examples of profiles and other variables of meteoro-
  logical interest are given, and comparisons are made with simultaneous data from colocated operational
  (NWS) sondes. An algorithm based on climatological statistics of measurements by radiosonde is used in
  the radiometric retrieval process, but there is no reliance of the products of the Profiler upon any
  current radiosonde data. The role of the Profiler in mesoscale and synoptic weather forecasting and its
  relationship to systems employing sounders on satellite platforms are also discussed.

WP-037
  HOGG, D. C., F. O. GUIRAUD, J. B. SNIDER, M. T. DECKER, and E. R. WESTWATER. A steerable dual-channel
  microwave radiometer for measurement of water vapor and liquid in the troposphere. J. Appl. Meteorol.
  22(5):789-806 (1983).

  An instrument that remotely senses the integrated amounts of water vapor and liquid on a path through
  the atmosphere is discussed. The vapor and liquid are measured simultaneously but independently by
  microwave radiometers. Comparison of the accuracy in measurement of vapor is made with radiosondes, and
  of liquid with an independent method employing transmission from a geosynchronous satellite. The instru-
  ment is designed for unattended operation: examples of measured data are given. Applications including
  observations for weather forecasting, weather modification, solar-radiation studies, and instrumentation
  for geodetic meteorology are also discussed.

WP-038
  HOGG, D. C., F. O. GUIRAUD, J. B. SNIDER, M. T. DECKER, and E. R. WESTWATER. Microwave radiometry for
  measurement of water vapor. "Reviews of Infrared and Millimeter Waves", Vol. I, Kenneth J. Button
  (ed.), Plenum Publishing Corporation, 113-154 (1983).

  No abstract.

WP-039
  Hootman, B. W. and W. Blumen. Analysis of nighttime drainage winds in Boulder, Colorado during 1980.
  Monthly Weather Review 111:1052-1061 (1983).

  Characteristics of nighttime drainage winds that occurred along the eastern slope of the Rocky Mountains
  around Boulder, Colorado during the calendar year 1980 are examined. The data used for this study were

acquired from the Boulder Wind Network (BWN) and from the Boulder Atmospheric Observatory (BAO). Data were available almost continuously from BWN and less frequently from BAO. BAO is a 300 m tower, instrumented at eight levels, but only surface wind observations are obtained from BWN. However, the combination of BWN and BAO observations represents a relatively unique set of wind data for the examination of drainage flows. Criteria for the identification of drainage winds are used to isolate events that are relatively free from external influences. Eighteen drainage wind events are identified, and some climatological features of the wind regime are established. In addition, the vertical structure of the flow associated with one event that reached the tower is examined in detail. Descriptions of the features of this flow and physical interpretations are presented. It is concluded, on the basis of this analysis, that observed features may be interpreted on the basis of the physical features contained in the model of Rao and Snodgrass (1981).

WP-040
HUFFAKER, R. M. Global wind measuring satellite system (WINDSAT) feasibility studies. Tech. Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology and Applications, August 1-4, 1983, Aspen, CO. Optical Society of America, TuC1-1 - TuC1-4 (1983).

No abstract.

WP-041
HUFFAKER, R. M., NOAA Contract Monitor. Feasibility study of a WINDSAT free flyer. RCA Final Report (1983).

No abstract.

WP-042
JANOPAUL, M. M., P. Broche, J. C. de Maistre, H. H. Essen, C. Blanchet, G. Grau, and E. Mittelstaedt. Comparison of measurements of sea currents by HF radar and by conventional means. International J. of Remote Sensing 3:409-422 (1982).

An analysis of remote measurements of sea surface currents during MARSEN is presented. Remote measurements were made by high-frequency (HF) radars in the German Bight from September to October 1979. Moored current meters made concurrent in situ measurements several metres below the surface. Comparisons of instantaneous data sets show differences, which may be explained by vertical current shear. The computed tidal coefficients from HF and current meter measurements agree well.

WP-043
JONES, R. M. Improved estimates of HF radiowave field strength near a land-sea interface. NOAA-TM-ERL-WPL-105 (1982).

Results of other researchers are extended to give the detailed behavior of mixed-path (land-sea or sea-land) propagation near the land-sea interface. It is shown that the mechanism for goundwave-mode coupling at the land-sea interface is edge-diffraction, and that near the shoreline the direct edge-diffracted wave can make a significant contribution to the field. It is further argued that, for sea-to-land propagation for an elevated observer, the sea-type groundwave modes extend over land, and there is a shadow zone for the land-type groundwave modes excited at the shoreline. Corresponding results hold for land-to-sea propagation.

WP-044
JONES, R. M., J. P. RILEY, and T. M. GEORGES. A versatile three-dimensional Hamiltonian ray-tracing computer program for acoustic waves in the atmosphere. NOAA-TM-ERL-WPL-103 (1982).

A FORTRAN computer program for tracing the paths of acoustic waves in the atmosphere is described. The program integrates Hamilton's equations for a medium that can be anisotropic (because of wind) and varies continuously in three dimensions. Several versions of the subroutines that specify the spatial variation of wind velocity, sound speed, temperature, and molecular weight are provided; the user can specify other atmospheric models by writing new subroutines following the examples. For each path, the program can calculate group path (group time delay as an equivalent path length), phase path (phase as an equivalent path length), Doppler shift due to a time-varying atmosphere, and geometrical path length. In addition to printing these parameters and the direction of the wave normal at various points along the raypath, the

program can plot the projection of the raypath on any vertical plane or on the ground and output the main characteristics of each ray in machine-readable form. The organization of the program into subroutines allows it to be applied to the propagation of waves in other media with straightforward modifications. The documentation includes equation, flow charts, program listings with comments, definitions of program variables, descriptions of input and output, and a sample case.

WP-045
   JONES, R. M. A survey of underwater-acoustic ray tracing techniques. NOAA-TM-ERL-WPL-111 (1983).

   A survey of techniques and features available in underwater acoustic ray tracing computer programs is presented. The survey includes methods for constructing raypath trajectories, constructing eigenrays, ray-intensity calculations, and ray theory corrections. The survey also includes models for sound speed (including interpolation methods), ocean bottom (including both bathymetry and reflection coefficient), ocean surface reflection coefficient, dissipation, temperature, salinity, and ocean current. In addition, methods for displaying models and methods for presenting ray tracing results are surveyed.

WP-046
   JONES, R. M. The role of edge diffraction in coupling of groundwaves at a land-sea interface. Proc. International U.R.S.I.-Symposium 1983, August 23-26, 1983, De Santiago de Compostela, Spain. URSI, 227-230 (1983).

   Groundwave mode-coupling coefficients at a discontinuity in ground surface impedance (as at a shoreline) are derived using the appropriate GTD (geometrical theory of diffraction) edge-diffraction coefficient. The results agree with previous derivations based on other methods. The discovery that edge diffraction is the mechanism for groundwave mode coupling at a shoreline or other similar discontinuity allows the calculation of groundwave mode coupling by edge diffraction in cases where no easily calculated solution is now available.

WP-047
   JONES, R. M., T. M. GEORGES, and J. P. RILEY. Ray tracing as an aid to inverting acoustic measurements in the Florida straits to monitor heat flux of the Gulf Stream. Digest, Vol. II, 1983 International Geoscience and Remote Sensing Symposium (IGARSS'83), Aug 31 - Sept 2, 1983, San Francisco, CA. URSI, FA-6, 4.1 - 4.7 (1983).

   We demonstrate a new, general-purpose, three-dimensional, underwater acoustic ray-tracing program by simulating acoustic measurements in the Florida Straits.

WP-048
   JONES, R. M., J. P. RILEY, AND T. M. GEORGES. A three-diemsnional ray-tracing program for atmospheric acoustic waves. Extended Abstract, 11th Congres International D'Acoustique, 19-27 July 1983, Paris, France, 1:7375 (1983).

   No abstract.

WP-049
   JONES, R. M., J. P. RILEY, and T. M. GEORGES. Measured ionospheric Doppler spreading of HF ground backscatter. NOAA-TM-ERL-WPL-109 (1983).

   Doppler spectra from ionospherically propagated ground backscatter are presented. These spectra show how the ionosphere distorts HF backscatter radio waves by frequency spreading. For example, such frequency spreading degrades ocean waveheight measurements by mixing first- and second-order parts of the sea-echo spectrum. The ground backscatter spectra presented here show that ionospheric Doppler spreading is so ubiquitous that its effect should never be disregarded, even when a narrow azimuth beam radar such as ours is used. Nevertheless, Doppler spreading varies so quickly that it usually pays to wait for it to diminish. For example, had we been measuring ocean waveheight under the ionospheric conditions present during our 25 minutes of ground backscatter measurements, the waveheight errors would have varied from about 20% to about 200% if the significant waveheight had been about 0.5 m. In fact, the waveheight error would have decreased from 200% to 20% in 5 minutes. The ionospheric Doppler spreading varies considerably as the reflection region in the ionosphere varies also. Phase spectra are also shown, and in contract with surface-wave sea-echo spectra, average skywave backscatter phase spectra have significant trends. Although multipath combined with differential ionospheric motions probably cause the observed Doppler

spreading, the multipath structure is not apparent in the observed spectra, which appear more continuous than discrete.

WP-050

KAIMAL, J. C., and J. E. GAYNOR. The Boulder Atmospheric Observatory. J. Appl. Meteorol., 22(5):863-880 (1983).

The Boulder Atmospheric Observatory (BAO) is a unique research facility for studying the planetary boundary layer and for testing and calibrating atmospheric sensors. The facility includes a 300 m tower instrumented with fast- and slow-response sensors, a variety of remote sensing systems, and a real-time processing and display capability that greatly reduces analysis time for scientists working with current or archived data. In the past four years of operation the BAO has been the site of several large cooperative experiments and numerous smaller ones. Details of the data acquisition, processing and archiving schemes are presented. Results of studies conducted and opportunities for future investigations are also described .

WP-051

Koepp, F., R. L. SCHWIESOW, and Ch. Werner. Laser Doppler anemometry applied to boundary-layer wind measurement. Preprint, 5th Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Ont., Canada. American Meteorological Society, 466-469 (1983).

No abstract.

WP-052

KROPFLI, R. A. A review of microwave radar observations in the dry convective planetary boundary layer. Boundary-Layer Meteorology, 26:51-67 (1983).

For the last two decades, radar has been used to probe the planetary boundary layer (PBL) in a number of different ways. The sensitive, high-power radars at Wallops Island, Virginia, were used to examine the refractive index structure of the PBL over hundreds of square kilometers with a resolution of several hundred meters. In these studies, fields of convective cells were documented over land and over the ocean. Vertically pointing FM-CW radars were used to observe the vertical structure of the PBL with resolution as good as 2 m. In addition, FM-CW radars, as well as conventional radars, have detected birds and insects in the PBL. Within the last seven years, dual Doppler radar was used to document the details of the velocity structure of the PBL in three dimensions. Recently, it has been shown that radar can be a useful tool for turbulence and diffusion measurements in the boundary layer.

WP-053

LAWRENCE, T. R. Comparison of the observed antenna gain properties of the NOAA Doppler lidar with theory. Tech. Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology and Applications, August 1-4, 1983, Aspen, CO. Optical Society of America, TuB1-1 - TuB1-4 (1983).

No abstract.

WP-054

Li, Xing-Sheng, J. E. GAYNOR, and J. C. KAIMAL. A study of multiple stable layers in the nocturnal lower atmosphere. Boundary-Layer Meteorology 26:157-168 (1983).

The structure of nocturnal inversions in the first 300 m of the atmosphere is analyzed using observational data from the Boulder Atmospheric Observatory (BAO) from March through June 1981. The temperature profiles show more than one inversion layer 41% of the time during the observational period. The vertical distributions of wind speed and moisture also show evidence of stratification during these multiple-layer events. The relation between the radiative cooling rate in time and height, including moisture, and the vertical structure of the multiple layers is calculated. The vertical distribution of eddy kinetic energy and the turbulent vertical fluxes of heat and momentum are also calculated. Turbulent structure in the elevated inversion layers is more complicated than that in the single-layer, stable nocturnal boundary layer. The total heat budget for a multiple-layer case is calculated, and turbulent cooling is found to be negligible relative to radiative cooling and to horizontal advection and/or horizontal divergence of heat flux.

WP-055
Lu, Nai-Ping, W. D. NEFF, and J. C. KAIMAL. Wave and turbulence structure in a disturbed nocturnal inversion. Boundary-Layer Meteorology 26:141-155 (1983).

Acoustic sounder and tower data obtained at the Boulder Atmospheric Observatory (BAO) are used to examine several features of the wave and turbulence structure associated with a disturbed nocturnal inversion. General features, including mean fields and Richardson number, fora the case selected for this study are presented. Spectral analysis of the tower data reveals a separation of energy into wavelike and turbulent fluctuations. Analysis of the heat flux, however, shows upward counter-gradient fluxes in the vicinity of a low-level jet and near the top of the inversion. Cospectral analysis shows that the major contribution to the upward heat flux occurs at frequencies that would normally be considered characteristic of waves. In some cases, the upward flux is associated with a phase shift between vertical velocity w and fluctuating temperature θ different from the quadrature relation that would be expected of internal waves. Time series analysis reveals that these unexpected positive fluxes occur in relatively short bursts. Analysis of time series of θ and w in other cases, as well as inspection of acoustic sounder records, shows that sometimes such upward fluxes can result from a combination of wave motion and horizontal temperature advection. In this case the advection is associated with a shallow cold front.

WP-056
McHugh, T., and K. Hancock. WINDSAT free flyer telescope concept using ultralightweight Beryllium technology. Tech. Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology and Applications, August 1-4, 1983, Aspen, CO. Optical Society of America, TuC5-1 - TuC5-4 (1983).

No abstract.

WP-057
McMillan, R. A. Bohlander, G. R. OCHS, R. J. HILL, and S. F. CLIFFORD. Millimeter wave atmospheric turbulence measurements: Preliminary results and instrumentation for future measurements. Optical Engineering, 22:032-039 (1983).

Increasing emphasis is being placed on the study of the effects of atmospheric turbulence on the propagation of millimeter and submillimeter waves because of the potential usefulness of these frequency bands in both military and civilian applications. The characterization of millimeter wave turbulence effects is more complicated than that of the optical propagation case because of a strong dependence on the humidity structure parameter C_Q^2 as well as on the temperature structure parameter C_T^2. In addition, there is a dependence on the cross-correlation of these two parameters, denoted by C_{TQ}. Measured results on the effects of atmospheric turbulence on millimeter wave propagation, which include both amplitude and phase fluctuations, are very limited and have generally been obtained incidental to other propagation measurements. However, comparison of these limited experimental results with theory has shown good agreement. This paper compares scattered results measured at 35.94, 140, and 220 GHz to theory, and shows that agreement in most cases is plausible. A future experiment specifically designed to characterize millimeter wave turbulence, with special emphasis on measurement of the pertinent atmospheric parameters, is also described.

WP-058
MONINGER, W. R., W. L. EBERHARD, G. A. BRIGGS, R. A. KROPFLI, and J. C. KAIMAL. Simultaneous radar and lidar observations of plumes from continuous point sources. Preprints, 21st Conf. on Radar Meteorology, Sept. 19023, 1983, Edmonton, Alta., Canada. American Meteorological Society, 246-250 (1983).

No abstract.

WP-059
MONINGER, W. R. Design and development of a radar control program for the NOAA/WPL pulse-Doppler radars. J. Climate and Appl. Meteorol. 22:859-862 (1983).

Development of a computer program to control and acquire data with meteorological research radars is described. The performance goals for the program are enumerated, and the implementation techniques to achieve these goals are discussed. Possible improvements to the program, suggested by experiences while using the program during a 4-month field experiment, are noted.

WP-060
  Moody, S. E., T. A. Znotins, and S. R. Byron. 100 watt average power CO_2 laser system for pulsed
  coherent lidar applications. Tech. Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology and
  Applications, Aug. 1-4, Aspen, CO. Optical Society of America, MC2-1 - MC2-4 (1983).

  No abstract.

WP-061
  OCHS, G. R., and R. J. HILL. A study of factors influencing the calibration of optical C_n^2 meters.
  NOAA-TM-ERL-WPL-106 (1982).

  We report the results of a study to identify factors affecting the calibration of optical C_n^2 meters of
  the modulated LED design. Design modifications to the 5 cm units have been made as a result of this
  study. The results indicate that a system working over 500 to 1000-meter paths, employing a 15-cm
  diameter transmitter and a single 15-cm diameter receiver, has advantages over the dual 5 cm systems in
  certain applications.

WP-062
  Parsons, D. B., R. A. KROPFLI, and J. M. Schmidt. Comparisons between Doppler radar derived air-motions
  in fixed and moving frames of reference. Preprints, 21st Conf. on Radar Meteorology, Sept. 19-23, 1983,
  Edmonton, Alta., Canada. American Meteorological Society, 558-564 (1983).

  No abstract.

WP-063
  PASQUALUCCI, F., and B. W. BARTRAM. A polarization-diversity millimeter-wave Doppler radar for meteoro-
  logical observations. Fifth Symposium on Meteorological Observations and Instrumentation, April 11-15,
  1983, Toronto, Ontario, Canada. American Meteorological Society, Boston, 432-436 (1983).

  No abstract.

WP-064
  PASQUALUCCI, F., B. W. BARTRAM, R. A. KROPFLI, and W. R. MONINGER. A millimeter-wavelength dual-
  polarization Doppler radar for cloud and precipitation studies. J. Climate and Appl. Meteorol.
  22:758-765 (1983).

  A pulse Doppler radar system operating at 35 GHz and having full polarization (linear and circular)
  diversity capability is described. Separate antennas are used for the transmitter and the receiver
  because this design approach allows better overall radar sensitivity. The transmitter operates in the
  double-pulse mode to optimize the unambiguous Doppler velocity measurable with the system. A polarizer
  capable of handling about 200 kW of peak power when pressurized with sulfur hexafluoride (SF_6) at 25 psi
  was developed for the transmitter. The radar system has built-in test sequences for checking the gain and
  alignment of the transmitter and receiver antennas. The dual-polarization intermediate frequency (IF)
  receiver has a total of six analog channels. A very flexible data acquisition and processing system has
  been developed to allow both coherent and incoherent dual-polarization measurements to be performed; the
  system includes a microprocessor-controlled pulse-pair processor and a minicomputer with associated
  peripherals. The radar was operated successfully in Montana during the 1981 Cooperative Convective
  Precipitation Experiment (CCOPE). Preliminary results on the observed variation of the circular depolari-
  zation ratio (CDR) are shown and related to the storm and cloud structure.

WP-065
  POST, M. J. Atmospheric aerosol profiles at CO_2 wavelengths. Technical Digest, 2nd Top. Mtg. on
  Coherent Laser Radar: Technology and Applications, August 1-4, 1983, Aspen, CO. Optical Society of
  America, ThB4-1 - ThB4-5 (1983).

  No abstract.

WP-066
  Rauber, R. M., L. O. Grant, and J. B. SNIDER. Spatial and temporal variations of cloud liquid water

determined by aircraft and microwave radiometer measurements in northern Colorado orographic storms. Proceedings of Conference on Cloud Physics, November 15-18, 1982, Chicago, Illinois. American Meteorological Society, 477-480 (1982).

No abstract.

WP-067

Rothermel, J., R. M. HARDESTY, C. Kessinger. Dual-Doppler analysis of lidar measurements taken during JAWS. Tech. Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology and Applications, Aug. 1-4, 1983, Aspen, CO. Optical Society of America, WA8-1 - WA8-4 (1983).

No abstract.

WP-068

RUFENACH, C. L., R. A. Shuchman, and D. R. Lyzenga. Interpretation of synthetic aperture radar measurements of ocean currents. Journal of Geophysical Research, 88:1867-1876 (1983).

Synthetic Aperture Radar (SAR) experiments have been performed over the last few years to measure ocean currents inferred from shifts in the Doppler spectral peak. Interpretations of aircraft SAR measurements, when compared with limited surface values, tend to underestimate the currents by about 25%. A theory is developed that modifies the classical Doppler expression showing that the radar measurements are dependent on the radar processor (system) bandwidth and the received signal bandwidth. Measured bandwidths give a correction that increases the inferred current values by about 25%, bringing the measurements into good agreement. This new correction lends credence to the theory and increases the potential for application of SAR systems to future ocean current measurements. SAR measurements should include the determination of processor and signal bandwidths such that this correction can be applied.

WP-069

SCHWIESOW, R. L. Potential for a lidar-based, portable, 1 km meteorological tower. J. Appl. Meteorol. 22(5):881-890 (1983).

Lidar measurements of wind, temperature and water vapor, using a variety of techniques that rely on the detection and analysis of laser light backscattered from the atmosphere, allow data to be obtained that are similar to those hypothetically available from a meteorologically instrumented tower extending to 1 km altitude (or more). This paper reviews these various recent accomplishments in lidar instrumentation without attempting historical completeness. Based on criteria of 1) altitude resolution to 50 m, 2) tower-like measurement geometry, 3) hardware commonality between techniques and 4) daytime as well as nighttime operation, the intercomparison results in recommended techniques to be combined for a compact, mobile lidar "tower." For horizontal wind, recommendations include pulsed time-of-flight lidar; for vertical wind, pulsed direct Doppler lidar at visible or shorter wavelengths; for temperature, Cabannes-scattering linewidth or rotational Raman band shape; and for water vapor, vibrational Raman scattering. Although further development of some of these techniques is needed to achieve the desired range and resolution, results in the literature support the conclusion that a lidar tower is a feasible concept for meteorological measurements under conditions allowing direct optical propagation.

WP-070

SHAPIRO, M. A., D. C. HOGG, and C. G. LITTLE. The Wave Propagation Laboratory Profiler System and its applications. Proceedings of the Fifth Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Ontario, Canada. American Meteorological Society, 174-182 (1983).

No abstract.

WP-071

Singstad, I. Polarization measurements with a pulsed coherent CO_2 Doppler lidar. Tech. Digest, 2nd Top. Mtg. on Coherent Laser Radar: Technology and Applications, Aug. 1-4, 1983, Aspen, CO. Optical Society of America, ThA10-1 - ThA10-4 (1983).

No abstract.

WP-072
  SNIDER, J. B. Observations of liquid water in orographic clouds using a steerable microwave radiometer.
  Fifth Symposium on Meteorological Observations and Instrumentation, April 11-15, 1983, Toronto, Ont.,
  Canada. American Meteorological Society, 196-198 (1983).

  No abstract.

WP-073
  STRAUCH, R. G., M. T. DECKER, and D. C. HOGG. Automated profiling of the troposphere. Journal of
  Aircraft, 20:359-362 (1983).

  A system operating at radio wavelengths, which continuously profiles the winds, temperature, and humi-
  dity of the troposphere, is discussed. Fixed-beam Doppler radar is used for measurement of the winds and
  tropopause height; millimeter-wave radiometry with antenna beams fixed-pointed to the zenith is used for
  temperature, humidity, and liquid measurements. The system operates unattended during almost all weather
  conditions; typical examples of data are presented.

WP-074
  STRAUCH, R. G., D. A. MERRITT, K. P. MORAN, K. B. EARNSHAW, and D. VAN DE KAMP. Tropospheric wind pro-
  filing with Doppler radar. Preprints, 21st Conf. on Radar Meteorology, Sept. 19023, 1983, Edmonton,
  Alta., Canada. American Meteorological Society, 118-125 (1983).

  No abstract.

WP-075
  Venkatram, A., D. Strimaitis, and W. EBERHARD. Dispersion of elevated releases in the stable boundary
  layer. Sixth Symp. on Turbulence and Diffusion, March 22-25, 1983, Boston, MA. American Meteorological
  Society, 297-299 (1983).

  No abstract.

WP-076
  Wang, T-i, D. C. Brinning, G. R. OCHS, and R. S. LAWRENCE. Optimization for the algorithms of an opera-
  tional laser weather identifier. NOAA-TM-ERL-WPL-107 (1982).

  We have built a prototype Laser Weather Identifier (LWI) including the vertical velocity measurement.
  The instrument has been collecting data since March 1981 for various types of precipitation. In this
  report, we discuss the data analysis and give our recommendations for the algorithms of an operational
  LWI.

WP-077
  Wang, T-i, R. LATAITIS, R. S. LAWRENCE, and G. R. OCHS. Laser weather identifier: Present and future.
  Journal of Applied Meteorology, 20:1747-1753 (1982).

  Prototype Laser Weather Identifier (LWI) systems designed to detect fog, rain and snow were tested for
  several months at Stapleton International Airport in Denver, and at the AFGL Weather Test Facility at Otis
  Air Force Base, Massachusetts. We present a detailed analysis of the performance of these systems, com-
  pared with human weather observations and tipping-bucket raingages, and suggest modifications for future
  operational instruments.

WP-078
  Werner, Ch., F. Köpp, and R. L. SCHWIESOW. Influence of clouds and fog on CW-LDA-systems. Technical
  Digest of 2nd Top. Mtg. on Coherent Laser Radar: Technology and Applications, August 1-4, 1983, Aspen,
  CO. Optical Society of America, WA9-1 - WA9-4 (1983).

  No abstract.

WP-079
  Werner, Ch., F. Köpp, and R. L. SCHWIESOW. DFVLR-remote slant visual range (SVR) and wind vector

measuring systems. Preprint, 9th Conf. on Aerospace and Aeronautical Meteorology, June 6-9, 1983, Omaha, Nebraska. American Meteorological Society, 247-251 (1983).

No abstract.

WP-080
WESTWATER, E. R., M. T. DECKER, A. Zachs, and K. S. GAGE. Ground-based remote sensing of temperature profiles by a combination of midrowave radiometry and radar. Journal of Climate and Applied Meteorology, 22:126-133 (1983).

This paper describes the results of a three-week experiment in which ground-based microwave radiometric measurements were combined with VHF radar measurements of tropopause height to yield vertical temperature profiles. Several algorithms to derive tropopause height are presented and their results are compared with radiosondes. The best of the algorithms yields radar versus radiosonde rms differences of ~0.65 km. By the use of the combined radar-radiometric method, improvements were obtained in rms temperature accuracy of as much as 2.0 K rms over the pure radiometric technique.

WP-081
WILSON, F. W., JR. Weighted least squares formulas for multiple Doppler radar analysis. Preprints, 21st Conf. on Radar Meteorology, Sept. 19-23, 1983, Edmonton, Alta., Canada. American Meteorological Society, 553-557 (1983).

No abstract.

WP-082
Yura, H. T., C. C. Sung, S. F. CLIFFORD, and R. J. HILL. Second-order Rytov approximation. Journal of the Optical Society of America, 73:500-502 (1983).

We obtain an explicit and useful formulation of the solution for the second-order Rytov approximation for an arbitrary source geometry. From this solution a condition of validity for the Rytov solution is obtained. We conclude that both the Born and the Rytov approximations have the same domain of validity.

ABOUT THE AUTHOR INDEX

All authors of all publications are listed.

An asterisk indicates a first author.

ERL authors' names are typed in <u>all</u> capital letters.

The words "et al." indicate that a publication had more than one author.

The alphanumeric code following an author's name gives the location of the biblio-
graphic entry. Example: WP-061 is the sixty-first entry in the Wave Propagation
Laboratory section.

Following are the codes used, their meanings, and inclusive pages.

<u>Code</u>	<u>Laboratory or Publishing Group</u>	<u>Pages</u>
AL	Aeronomy Laboratory	1-10
AO	Atlantic Oceanographic and Meteorological Laboratory	38-53
AR	Air Resources Laboratory	11-37
CR	Climate Research Project	54-55
GF	Geophysical Fluid Dynamics Laboratory	64-72
GL	Great Lakes Environmental Research Laboratory	73-84
NS	National Severe Storms Laboratory	85-95
PM	Pacific Marine Environmental Laboratory	96-110
PR	Program for Regional Observing and Forecasting Services	60-61
RF	Research Facilities Center	111-112
SE	Space Environment Laboratory	113-129
WM	Weather Modification Program	62-63
WP	Wave Propagation Laboratory	130-143
WR	Weather Research Program	56-59

AUTHOR INDEX—ADDENDUM

148

149

*KAMIDE, Y., et al., SE-030
*KAMIDE, Y., et al., SE-031
 KAMIDE, Y., et al., SE-038
 KAMIDE, Y., et al., SE-039
 KAMIDE, Y., et al., SE-046
*KAMIDE, Y., SE-025
*KAMIDE, Y., SE-026
 KAMP, D. VAN DE, et al., WP-074
 Karl, T. R., et al., AR-013
 Kaskiewicz, P. F., et al., WP-002
 Keeler, J., et al., NS-031
 Keene, W. C., et al., AR-032
 KELLEY, R. N., et al., GL-041
 Kellogg, P. J., et al., SE-061
 KELLY, K., et al., AL-029
 Keppler, E., et al., SE-049
 Kessinger, C., et al., WP-067
 KESSLER, E., et al., NS-012
*KESSLER, E., NS-013
 Keto, E., et al., GF-017
 Khalil, M. A. K., et al., AR-093
 Kihl, R., et al., AR-038
*Kikuchi, T., et al., SE-033
*KIKUCHI, T., SE-032
 Kiladis, G., et al., CR-002
 Kinder, T. H., et al., PM-001
*Kinder, T. H., et al., PM-027
 Kinder, T. H., et al., PM-049
 Klemp, J., et al., NS-026
*KLEY, D., et al., AL-029
 KLEY, D., et al., AL-030
 Knight, N. C., et al., NS-033
 Knox, R. A., et al., PM-020
*Koepp, F., et al., WP-051
*KOMHYR, W. D., AR-054
*KOMHYR, W. D., et al., AR-055
 Koomen, M . J., et al., SE-057
 KORSHOVER, J., et al., AR-002
*KORSHOVER, J., et al., AR-056
 KOSCIELNY, A. J., et al., NS-010
*KOSCIELNY, A. J., et al., NS-014
 Krall, K. R., et al., SE-050
 Kroehl, H. W., et al., SE-027
 Kroehl, H. W., et al., SE-029
 KROPFLI, R. A., et al., WP-018
 KROPFLI, R. A., et al., WP-019
 KROPFLI, R. A., et al., WP-058
 KROPFLI, R. A., et al., WP-062
 KROPFLI, R. A., et al., WP-064
*KROPFLI, R. A., WP-052
 Kropp, F., et al., WP-078
 Kropp, F., et al., WP-079
*Kuhn, P. M., et al., WR-011
 Kundu, M. R., et al., SE-050
 KURIHARA, Y., et al., GF-001
*KURIHARA, Y., et al., GF-009
 KURIHARA, Y., et al., GF-035
 Kurkowski, R. L., et al., WR-011
 KUSTER, W. C., et al., AL-024
*LAGERLOEF, G., PM-028
 LAIRD, G. A., et al., GL-018
 LAMB, M. F., et al., PM-015
*Lamb, R. G., AR-057
 Lander, J. F., et al., PM-006
 LANDRUM, P. F., et al., GL-007
 LANDRUM, P. F., et al., GL-012
 LANDRUM, P. F., et al., GL-013

 LANDRUM, P. F., et al., GL-016
 LANDRUM, P. F., et al., GL-020
 LANDRUM, P. F., et al., GL-026
*LANDRUM, P. F., et al., GL-034
 LANDRUM, P. F., et al., GL-050
*LANDRUM, P. F., GL-033
 Langer, G., et al., WM-004
 LATAITIS, R. J., et al., WP-011
 LATAITIS, R. J., et al., WP-077
*LAVELLE, J. W., et al., PM-029
 Lawrence, G. M., et al., AL-031
 LAWRENCE, R. S., et al., WP-076
 LAWRENCE, R. S., et al., WP-077
 LAWRENCE, T. R., et al., WP-025
*LAWRENCE, T. R., WP-053
 LAWSON, R. E., Jr., et al., AR-018
*LAWSON, R. E., Jr., et al., AR-058
*LAWSON, R. E., Jr., et al., AR-059
 LAWSON, R. E., Jr., et al., AR-097
 Leaman, K. D., et al., PM-031
 LEAN, J., et al., SE-014
*LEAN, J. L., AR-060
 LEAN, J. L., et al., AR-023
 LEAN, J. L., et al., AR-024
*LEAN, J. L., et al., AR-061
*LEAN, J. L, et al., AR-062
 Lee, J. T., et al., AR-097
 LEE, J. T., et al., NS-035
*LEE, J. T., NS-015
 Lee, R. W., et al., WP-030
 Leetmaa, A., et al., PM-019
 Leversee, G. J., et al., GL-007
 Leversee, G. J., et al., GL-050
*LEVITUS, S., GF-010
*Li, Xing-Sheng, et al., WP-054
 Likens, G. E., et al., AR-032
 Lindinger., W., et al., AL-012
 Lindstrom, E. J., et al., PM-031
*LIPPS, F. B., et al., GF-011
 LITTLE, C. G., et al., WP-036
 LITTLE, C. G., et al., WP-070
 LIU, P. C., et al., GL-035
 LIU, P. C., et al., GL-046
 LIU, S. C., et al., AL-011
*LIU, S. C., et al., AL-030
 Livingston, W. C., et al., AR-062
 London, J., et al., AR-075
 Long, R., et al., PM-018
 LOPEZ, R. E., et al., WR-009
*LOPEZ, R. E., et al., WR-012
*LOPEZ, R. E., et al., WR-013
*LOPEZ, R. E., et al., WR-014
*Lovelock, J.E., et al., AR-063
*Lu, Nai-Ping, et al., WP-055
 Luyten, J. R., et al., PM-031
*LYONS, L. R., SE-034
 Lyzenga, D. R., et al., WP-068
*MacAyeal, D. R., GF-012
*MACGORMAN, D. R., et al., NS-016
 MACGORMAN, D. R., et al., NS-027
 MACGORMAN, D. R., et al., NS-030
*MACKLIN, S. A., PM-030
*Madden, R. P., SE-035
 MADDOX, R. A., et al., WR-001
 MADDOX, R. A., et al., WR-004
 MADDOX, R. A., et al., WR-006
*MADDOX, R. A., et al., WR-016

*MADDOX, R. A., WR-015
*Mahapatra, P. R., et al., NS-017
*Mahapatra, P. R., et al., NS-018
*Mahapatra, P. R., et al., NS-019
 MALCZYK, J. M., et al., GL-017
 MALCZYK, J. M., et al., GL-036
*Malm, W., et al., AR-064
*MANABE, S., et al., GF-016
 MANABE, S., et al., GF-037
*MANABE, S., GF-013
*MANABE, S., GF-014
*MANABE, S., GF-015
 MANGUM, L. J., et al., PM-023
 MANGUM, L. J., et al., PM-024
*MANGUM, L. J., et al., PM-032
 Maresca, J. W., Jr., et al., WP-022
 Marsh, G. L., et al., AR-009
 Martin, B., et al., AR-030
 MASSOTH, G. J., et al., PM-015
 Mathis, J. J., Jr., et al., AR-107
 Mathur, M., et al., PM-018
 Matsushita, S., et al., SE-029
*MATT, D. R., et al., AR-065
 Maurer, H., et al., SE-027
 Maurer, H., et al., SE-029
*Maxwell, A., et al., SE-036
 Maxwell, A., et al., SE-060
*Mazur, V., et al., NS-020
 Mazur, V., et al., NS-027
*MC FEE, C., et al., AR-066
 McCORMICK, M. J., et al., GL-013
 McCORMICK, M. J., et al., GL-030
 McDowell, S. E., et al., PM-031
 MCFARLAND, M., et al., AL-029
 MCFARLAND, M., et al., AL-030
*MCGINLEY, J., NS-021
*McHugh, T., et al., WP-056
 McINTOSH., P. S., et al., SE-009
*McMillan, R. W., et al., WP-057
*MCMILLEN, R. T., AR-067
 MCMILLEN, R. T., et al., AR-065
*MCMILLEN, R. T., et al., AR-068
 MCMILLEN, R. T., Jr., et al., AR-004
 McNamara, A. G., et al., SE-061
*McWilliams, J. C., et al., PM-031
*Meadows, G. A., et al., GL-035
 Mechoso, C. R., et al., GF-017
*Mellor, G. L., et al., GF-017
*Mellor, G. L., et al., GF-018
 MENDONCA, B. G., et al., AR-019
 MENDONCA, B. G., et al., AR-021
 MENDONCA, B. G., et al., AR-066
 MERCERET, F. J., et al., RF-009
*MERCERET, F. J., RF-005
*MERCERET, F. J., RF-006
*MERCERET, F. J., RF-007
 MERRILL., R. G., et al., SE-024
 MERRILL, R. G., et al., AR-044
 MERRITT, D. A., et al., WP-036
 MERRITT, D. A., et al., WP-074
*Mesinger, F., et al., GF-019
 Michels, D. J., et al., SE-057
 Mihalov, J. D., et al., SE-017
 MILBURN, H. B., et al., PM-002
 MILBURN, H. B., et al., PM-012
 MILLER, J. M., et al., AR-032

*MILLER, J. M., et al., AR-069
*MILLER, S. W., et al., AR-070
*MILLER, S. W., et al., AR-071
 Mittelstaedt, E., et al., WP-015
 Mittelstaedt, E., et al., WP-042
*MIYAKODA, K., et al., GF-021
 MIYAKODA, K., et al., GF-028
*MIYAKODA, K., GF-020
 MOBLEY, C. D., et al., PM-036
 MOBLEY, C. D., et al., PM-037
 MOBLEY, C. D., et al., PM-038
 MOBLEY, C. D., et al., PM-039
 MOBLEY, C. D., et al., PM-040
 MOEN, P. D., et al., PM-050
 MOFJELD, H. O., et al., PM-029
*MONINGER, W. R., et al., WP-058
 MONINGER, W. R., et al., WP-064
*MONINGER, W. R., WP-059
 Monteith, T. J., et al., GL-049
 Moody, S. E., et al., WP-007
*Moody, S. E., et al., WP-060
 MORAN, K. P., et al., WP-036
 MORAN, K. P., et al., WP-074
 MOREHEAD, N. R., et al., GL-012
*Mount, G. H., et al., AL-031
 Muhs, D., et al., AR-038
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 Murphy, A. H., et al., WR-016
 Murphy, P. C., et al., AL-028
 Murphy, P. C., et al., AL-035
 Murthy, C. R., et al., GL-046
 NAGAMOTO, C. T., et al., AR-104
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 NAGAMOTO, C., et al., WM-005
 NAGAMOTO, C., et al., WM-007
 Nakagawa, Y., et al., SE-059
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 NALEPA, T. F., et al., GL-012
 NALEPA, T. F., et al., GL-018
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 Namias, J., et al., CR-003
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 NAPPO, C. J., et al., AR-015
 NAPPO, C. J., et al., AR-089
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 NEFF, W. D., et al., WP-055
 Nelson, F., et al., GL-025
 NELSON, S. P., et al., NS-003
 NELSON, S. P., et al., NS-011
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 NICKERSON, E., et al., WM-007
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 NOLT, I., et al., WM-007
 NORTON, R. B., et al., AL-024
 NORTON, R. B., et al., AL-028
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 NORTON, R. B., et al., AL-034
 NOXON, J. F., et al., AL-031
*NOXON, J. F., et al., AL-034
 O'Brien, J., et al., PM-018
 OCHS, G. R., et al., WP-033
 OCHS, G. R., et al., WP-057

154

*Weaver, J. F., et al., WR-019
*Weber, A. H., et al., AR-107
 WEBER, B. F., et al., WP-025
 WEBER, B. L., et al., WP-016
 WEIKMANN, H. K., et al., WM-006
*WEINSTOCK, J., AL-048
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 Weiss, I., et al., SE-010
 Weiss, I., et al., SE-011
 Weiss, I., et al., SE-063
 Weissman, D. E., et al., PM-051
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 WELLMAN, D. L., et al., AR-003
 WELLMAN, D. L., et al., AR-085
 WELLMAN, D. L., et al., AR-094
 WELLMAN, D. L., et al., AR-105
*WELSH, J. G., GF-036
 Wenzel, K.-P., et al., SE-049
 Werner, Ch., et al., WP-051
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 Wesely, M. L., et al., AR-048
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 WESTWATER, E. R., et al., WP-031
 WESTWATER, E. R., et al., WP-036
 WESTWATER, E. R., et al., WP-037
 WESTWATER, E. R., et al., WP-038
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 WETHERALD, R. T., et al., GF-037
 Whalen, B. A., et al., SE-061
 White, O. R., et al., AR-062
 WHITE, R. K., et al., GF-028
 Wilhelmson, R., et al., NS-026
 Williams, A. J., et al., WP-001
 WILLIAMS, D. J., et al., SE-020
 Williams, G. M., et al., AR-103
*WILSON, F. W., JR., WP-081
 Winant, C. D., et al., PM-001
 Winart, C. D., et al., WP-001
 WINKLER, R. H., et al., AL-029
 WISEGARVER, D. P., et al., PM-012
 WISEGARVER, D., et al., AR-033

 WISEGARVER, D., et al., PM-016
 Woldvogel, A., et al., NS-031
 Wolfson, C. J., et al., SE-060
 WOOD, V. T., et al., NS-004
 WORNOCK, J. M., et al., AL-025
*WRIGHT, P. B., PM-054
*WRIGHT, P. B., PM-055
 Wu, S. T., et al., SE-019
 Wu, S. T., et al., SE-056
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 Yamada, T., et al., GF-018
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 Zachs, A., et al., AL-047
 Zachs, A., et al., WP-080
 Zafiriou, O., et al., AL-030
 ZAHRAI, A., et al., NS-036
 Zaitsev, A. N., et al., SE-027
 Zaitzev, A. N., et al., SE-029
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 Zawodny, J. M., et al., AL-031
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 Znotins, T. A., et al., WP-006
 Znotins, T. A., et al., WP-007
 Znotins, T. A., et al., WP-060
 ZRNIC', D. S., et al., NS-009
 ZRNIC', D. S., et al., NS-017
 ZRNIC', D. S., et al., NS-018
 ZRNIC', D. S., et al., NS-019
 ZRNIC', D. S., et al., NS-029
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